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THE DEDICATION OF THE IRVING PORTER CHURCH MEMORIAL TELESCOPE.

By SAMUEL L. BOOTHROYD.

Exercises formally dedicating the Irving Porter Church Memorial Telescope of the Fuertes Observatory of Cornell University were held on the evening of June 15, 1923.

Brief addresses of presentation and acceptance by Dean Kimball and President Farrand preceded the address of the evening by Dr. Heber D. Curtis, Director of the Allegheny Observatory.

After the lecture by Dr. Curtis, the members of Professor Church's class and their friends were invited to the observatory to see the telescope and to view Jupiter and Saturn and the Globular Cluster in Hercules through it. A goodly number availed themselves of the opportunity and were favored with clear skies and good "seeing." As there had been public nights at the observatory each Friday night since the Easter vacation it was deemed wise only to invite the members of the class of 1873 and their friends who came to Cornell for the celebration of their fifty year reunion, and attended the dedication exercises for the interest the occasion afforded and to do honor to their classmate who had made the occasion possible.

As just intimated, the initial impulse which has made possible the memorable occasion here recorded, an occasion which means so much to Cornell University, was given by Professor Church, Emeritus, in 1919 when he made arrangements to get for the Fuertes Observatory two discs of glass for a 12-inch objective which had been ordered from the Mantois Factory near Paris by the Yerkes Observatory. Owing to delays caused by the war, these were no longer of use to the Yerkes Observatory and so were released to Cornell University.

In March, 1919, the order was given to the John A. Brashear Co. to make these discs into a visual objective for a 12-inch equatorial for Cornell University. A little over a year later the completed objective was received by the treasurer and stored for safe keeping in the vault at the treasurer's office to be kept until such time as the necessary funds should become available for the purchase of the 12-inch equatorial mounting.

Professor Church now initiated and carried forward a movement to get contributions from Alumni of the College of Civil Engineering of Cornell University to complete a fund for the purchase of the mounting for the lens which his generosity had provided. The Cornell So-

ciety of Civil Engineers gave a substantial contribution and by the fall of 1921, when the writer arrived to take charge of the work in Astronomy and Geodesy, a goodly sum had been raised, Professor Church himself contributing liberally to the project.

During the fall of 1921 the proposal of Director Barnes of the School of Civil Engineering to call the telescope the Irving Porter Church Memorial Telescope was, by common consent, approved and Alumni were appealed to again to complete the fund as a fine means of honoring one who has done so much for Cornell University, and whose interest in astronomy for its value in broadening, enlarging and uplifting man's vision, is known to all who have the pleasure of his intimate acquaintance.

In December, 1921, owing to a happy coincidence, the firm of Warner and Swasey, through the kindly interest of Mr. E. P. Burrell, himself a Cornell graduate, and other members of the firm, was able to make the University a most generous offer for the construction of the equatorial mounting for the 12-inch lens, an offer so generous that, in spite of the fact that the full amount needed was not yet raised, the trustees gave the order for the mounting early in January, 1922. During the spring of 1922, Dean E. E. Haskell, Emeritus, who had already done much to bring the need of completing the fund for the purchase of the mounting to the attention of Alumni, came to the rescue, and through his kindly offices in further presenting the need, the fund was completed about the same time that the last payment to the Warner and Swasey Company came due. The total amount was contributed by about twenty-five alumni, all but one whom were graduates of the College of Civil Engineering, and the one exception was a graduate of Sibley College. The contribution from the Cornell Society of Civil Engineers may be regarded as the sum of a large number of contributions from Civil Engineering graduates, the whole gift being a fine memorial to a much beloved teacher in the College of Civil Engineering.

The mounting was finished and ready for shipment in July, 1922, but, owing to repairs and improvements to be made on the building and dome of the Fuertes Observatory, it was not shipped until late in September and its erection in the dome was completed on October 16, 1922.

The telescope is provided with a photographic correcting lens and with two cameras, one for taking photographs at the principal focus and one for use with amplifying lenses. The focal length of the objective is 180 inches and two amplifying lenses give equivalent focal lengths of 5 and 10 times as great.

The instrument is provided with the usual coarse circles for setting the hour angle and declination, and a disc on the N. face of the pedestal and driven by the clock makes it possible to set right ascensions direct, being read by a vernier to single minutes of right ascension. There are also fine circles, graduated on silver, for reading the decli-

nation and hour angle and reading to ten seconds of arc and one second of time respectively.

The pedestal rests on two pairs of 18-inch I-beams which are 30 feet long, the ends being built into the main walls of the central part of the building. To increase the stiffness of the I-beams the upper north and south pair are bolted and braced to the east and west pair at their centers, just under the pedestal.

Adjusting screws for the fine adjustment of the polar axis in altitude and azimuth are provided on the base of the pedestal.

A small bifilar micrometer, which was originally provided for the original 4-inch equatorial telescope of the observatory, has been fitted with an adapter which makes it possible to use it on the 12-inch until such time as funds become available to purchase a more suitable one.

A fine assortment of eye-pieces and a polarizing helioscope have been provided by the generosity of Director Barnes of the School of Civil Engineering and it is hoped that other generous Alumni will, before long, supply the necessary funds for the purchase of a spectrograph and perhaps later an objective prism.

Tests of the objective on double stars show that it readily resolves stars of approximately equal brightness which are one-half second apart and when the seeing is unusually good the writer has recognized even closer pairs as double. These and other tests have shown that the objective is up to the usual standard of excellence attained by Brashear lenses.

The driving clock, the worm and worm wheel, as well as the mounting generally, are up to the usual standard of incomparable excellence for which the work of Warner and Swasey has won such deserved distinction.

The addition of this fine equatorial to the very complete equipment for teaching geodetic astronomy marks a noteworthy epoch in the history of astronomy at Cornell University.

ARCTURUS.

O golden star Arcturus!
Bright beacon of our sky,
That, rising in the winter,
Announces spring is nigh,
Which reigns with azure Vega,
Each sultry summer night,
And when the leaves are falling
Steals westwardly from sight.

O golden sun Arcturus!
Huge furnace of our sky,
Whose satellites whirl round him,
Unseen by human eye;
Among the Herdman's jewels,
He keeps his constant place,
Although like swift projectile
He speeds through starry space.

—CHARLES NEVERS HOLMES.

41 Arlington St., Newton, Mass.

THE INFLUENCE OF ASTRONOMY UPON MODERN THOUGHT.*

By HEBER D. CURTIS.†

We humans are so much a part of our environment, as well as a product of it, that there are few factors in that complex which we call modern civilization which, though created by us, are not also operating to create in us a new mentality. Nearly every factor of our mental or spiritual activity, nearly every material product of our present life, has been taken at one time or another as an index of the height of the civilization of the community or race producing it. The standard of progress of a nation has more than once been measured by the amount it produces of such widely different substances as sulphuric acid, steel billets, or wheat. Forms and peculiarities of governmental mechanisms, and fashions of religious belief, have been employed to the same end. Within certain limits and with proper precautions, such indices, of material progress at least, are legitimate and apparently trustworthy.

But it is more difficult to appraise the present effect, and wellnigh impossible to foretell the future influence upon our mass intellect and mass bodily mechanism of even minor inventions, discoveries, or concepts.

Let us take a concrete illustration in the persons of Mr. and Mrs. John Smith, average citizens, grading not too high in the Army Intelligence Tests, and thus fairly representative, interested, let us say, only in the retail clothing trade. It is quite possible that the ancestors of this pair, certainly the feminine half, have for several thousand years had an amount of mechanical ability sufficient to permit their comprehension of no mechanical device more complicated than a door-hinge or a pair of scissors. Today, stern necessity caused by an occasional break-down, and the inevitable grooming required by the gasoline horse, forces them both to an understanding of the purpose of a castellated nut, and enables them to speak with some authority of ignition systems and differential gear assemblies. Ten million people of these United States have thus secured a vastly increased coördination of swift and certain muscular action, a necessity in driving a two-ton machine at thirty miles per hour, not to mention a tremendous increase in the knowledge of mechanisms formerly familiar only to machinists and engineers. Daimler certainly never anticipated such intellectual adaptations and re-adjustments as the result of his invention of the internal combustion engine. Thrice as many millions weekly

*An address delivered June 15, 1923, at Cornell University, on the occasion of the dedication of the Irving Porter Church Memorial Telescope of the Fuertes Observatory. The address was illustrated with numerous lantern slides, inexpedient to reproduce in its published form.

†Director, Allegheny Observatory.

obtain a large part of their reading matter, most of such propaganda as they can absorb, much of their quota of emotional excitement, and all of their drama, from sixteen photographs per second imprinted upon a long celluloid film. Who can predict the effect of Hollywood upon the mentality and particularly upon the spiritual natures of our great-grand-children a century hence?

That man, having created certain tools, has himself been made over and re-created through the use of these tools is so well known a truism as scarcely to require repeating. Some of this adaptation to changed environment has been purely physical, from the mechanical use of such tools, though for the most part our muscular coördination has simply been changed in the character of its application, rather than in its absolute amount. Though we can not throw a boomerang, nor easily chip out an arrow-head from flint, we can write, and we can steer an auto.

But the effect of our mental and spiritual tools has been enormous, all-embracing, cataclysmically subversive; revolutionary in leaving atrophied the abandoned concepts; evolutionary in its creation of new mental attitudes towards our environment.

In the influence of astronomy upon modern thought we encounter no such sudden and explosive effect as that which we find when we consider the recent birth and rapid rise of the theory of evolution, only a theory seventy-five years ago, now the foundation of every thesis of scientific or philosophical thought, and the universal cementing liaison which binds all such together. The growth of the influence of astronomy has been most leisurely, but the total effect of these slowly acquired concepts has nevertheless been of very great weight. Though the extent of the visible universe was absolutely unknown, and though the true mechanism of even our solar system was but imperfectly understood, the wonders of the heavens have for centuries been the inspiration of philosophical speculations, or even of religious systems.

Five centuries ago, with but rudimentary and fragmentary knowledge of the universe without, science, philosophy, and religion alike were anthropocentric and geocentric. We shall perhaps never, as men, come to any other viewpoint than that which holds that the noblest study of mankind is man, but we can today scarcely realize the change in philosophical thought which has come with the abandonment of our earth as the center of the universe. Even in the short span of our own lives we have seen a host of new concepts and discoveries; these we have had no trouble in assimilating gradually, one by one. Our children have these all thrust upon them as completed products. They must accept *in toto*, and with none of the preparation given by development and growth, such marvels as the moving picture, the automobile, radio, the X-ray. It is perhaps not surprising that our children seem to us a bit blasé, and that it takes a new wonder of extraordinary character to arouse a thrill in them. We, like them, accept

our sun-centered solar system ready made, and can not easily realize the mental troubles of our ancestors when they were forced to give up the convenient and logical idea that the earth was the center of the universe, with the sun, moon, and stars so placed around it as to give mankind light, life, and spiritual pleasure. In place of the rather vague and indefinite knowledge of two centuries ago, when astronomical science furnished little certain knowledge of any space realms outside the narrow confines of our own solar system, we today have a fairly definite body of theory as to the size and shape of that agglomeration of stars to which we belong as a minor and inconspicuous unit, and which we call our galaxy, or Milky Way. This increased knowledge is reacting, and will long continue to react powerfully upon our mental attitude toward the universe in which we find ourselves placed.

It is far from the purpose of this address to attempt to justify the study of astronomy by stressing some of its practical applications; it is of value for its own sake. There are, it is true, numerous such applications, even though the bearing of some of them upon our daily life may be more or less indirect. We furnish the world with its science of time; without astronomy, there could be no navigation; the laboratories of the stars, through spectrum analysis, have here and there important points of contact with our terrestrial laboratories of physics and chemistry; the civil engineer uses our results in all his more accurate surveying and geodetic operations. But, aside from the needs of instruction, it is probable that one large observatory could accumulate all the data needed for these practical ends, and the pure research of a modern observatory has but few and remote contacts with the norms of bills rendered and cash receivable.

While we render services to the engineer, it is probable that the engineer gives us in return more than he receives from us, for our great modern telescopes with their domes, rising floors, and other accessories, have come to be essentially engineering problems. It is now about thirty years since modern engineering practice, aided by the genius of Warner and Swasey, was first applied to a giant telescope. The success of their work may best be judged by the fact that most refractors built since that time have been practically exact copies of that first fruit of their skill, the 36-inch telescope at Lick Observatory. It may be affirmed without exaggeration that modern astronomy would have been impossible without the contributing skill of the engineer.

A very brief survey of certain results of recent astronomical research will serve to form a foundation for some points in the influence of astronomy upon present concepts which I desire to emphasize later. In selecting such isolated facts from the great mass of results given us by the astronomical research of the past half-century I must necessarily pass over without mention a great majority of the more interesting celestial phenomena, each of which might well exhaust the time available for this presentation; such subjects as eclipses, the comets,

the nebulae, the planets, and especially Mars, so perennially alluring to the newspaper reporter and space-writer.

The journey which we shall make in spirit tonight is one of tremendous extent, but we shall break this journey for a moment's consideration of our sun, for one very important reason. Of the roughly two billion stars which form our galaxy we know the distances of only a few thousand. However, for a number of cogent reasons, we feel certain that these few thousand are quite representative in character. The vast majority of the two billion stars are quite surely not very different, on the average, from these our nearer neighbors whose distances we have been able to determine. These distances give us, then, a mass of information as to the average intrinsic brightness, mass, temperature, etc., which must be approximately true for the stars in general. The spectroscope tells us, as well, that most of the stars can be grouped as to constitution in an astonishingly small number of general classes, perhaps not more than ten principal sorts. The spectroscope gives at the same time rather definite evidence to the effect that there is no break in the continuity of matter and energy, and it seems improbable that there exists anywhere among this host of stars any sort of stuff other than the ninety-two kinds of matter known to us.

Now perhaps the most important deduction to be made from our present knowledge of the stars is this:—we find that our sun is a fair average of the stars in general. There are numerous stars brighter than our sun; there are very many which are fainter.

As we admire a photograph of the dense star clouds of the Milky Way we shall need to keep constantly in mind a single very simple equation, namely,—every star is a sun, and our sun is an average star. It is an equation which is correct, not for individual units, but in the general average; far the greater portion of the hundreds of thousands of minute points in a Milky Way photograph are suns of roughly the same mass, size, and brightness as our sun. To repeat, pick out any point of light in such a picture at random, and the chances are quite good that it is somewhere near the brightness of our sun; quite probably it is of the same order of size, that is,—averaging perhaps one million miles in diameter; quite probably also, its mass will average in the neighborhood of that of the sun, which, expressed in tons, is the figure two followed by twenty-seven ciphers. Blot out one point of light in such a photograph and you have destroyed a sun. Move our entire solar system out to this distance and we have but added one more dot to the bewildering complex.

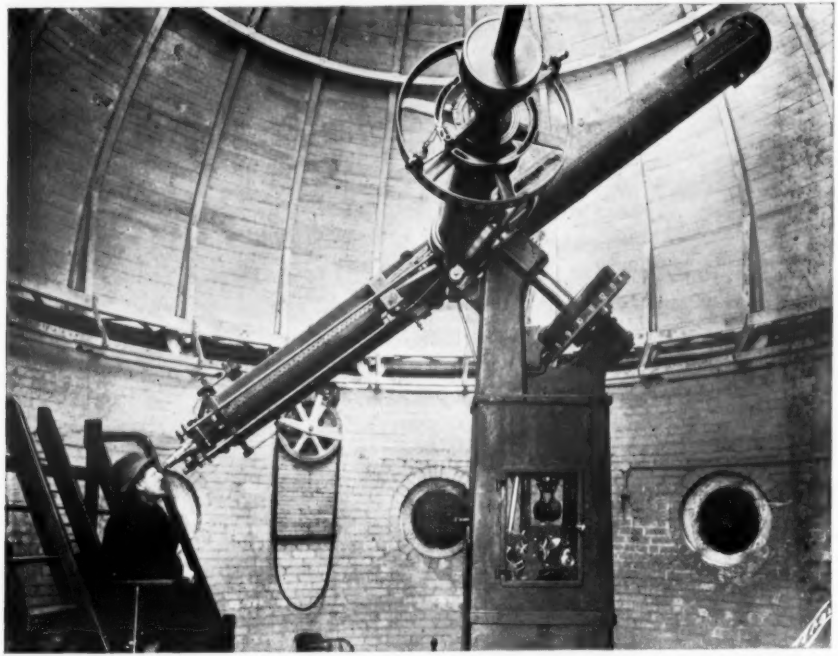
The most casual glance at the Milky Way on a clear, moonless night leaves the impression that the stars must be very much more numerous in that faint band of light than is general over the rest of the sky and our photographs and star counts more than confirm this impression. Photographs have been taken of dense star clouds in the Milky Way which show at least 80,000 stars in an area the size of the full moon, while there may be visible but a few hundred in a similar

area some distance from the Milky Way. Combining thus the results of studies of stellar distribution with our knowledge of the characteristics of the average star, it has been possible to learn the more salient features of our galaxy. We find that it probably contains two billion suns, and that it is a rather flat, round structure, much like a reading-glass or a thin pocket watch in shape. As to the size of this lenticular space in which are located the two billion brothers of the sun, and in the approximate center of which is floating our insignificant solar system, there is some difference of opinion. While no accurate dimensions can be given, many astronomers believe that our Milky Way is somewhere about 30,000 to 50,000 light-years in diameter, and perhaps 6,000 light-years in thickness (the distance which light traverses in one year, nearly six trillion miles, forms a convenient unit of stellar distance). We find further that one of the most remarkable characteristics of this galaxy is its essential simplicity. Unlike the millions of species catalogued in our terrestrial flora and fauna, there are only some four or five main classes of celestial objects:—the stars; the star clusters; the diffuse nebulae, which many believe to be the primordial stuff from which the stars have been formed; the small and rather exceptional planetary nebulae; and the spirals.

In a star cluster we are beholding a closely packed mass of from fifty to one hundred thousand suns, and its distance is of the order of ten thousand light-years. Modern magic! As youngsters we used to read of Aladdin and his wonderful lamp, which when rubbed would summon a djinn to perform any task demanded by the old-time magic. How insignificant seems the magic of fancy in comparison with the magic of a photograph of distant star-clouds, or a beautiful cluster. Waves of light, and precisely what they are we do not yet know, making trillions of oscillations per second, started on their long journey across space towards us ten thousand years ago. Just what is the medium, if there be one, which carried them across this expanse we do not know. Much diminished in strength, but still perceptible, an infinitesimal portion of these vibrations finish their ten-thousand-year journey in the direction of our telescope, enter it, and, so far as we know, with just as many oscillations per second as when they started, beat for several hours upon the silver grains imprisoned in the film of our photographic plate. Here, too, we do not know the precise mechanism of the countless blows they inflict upon the silver grain, but we finally, after some simple chemical manipulation, obtain the autograph of unnumbered suns quadrillions of miles away. Modern magic!

The epoch at which we observe such suns is roughly seven thousand years before Tut-ankh-amen's time. In one way of viewing this fact, we are effectively ten thousand years old as we view such a star cluster. But there is another interesting phenomenon involved here which, so far as I know, has not been emphasized hitherto. The remote past is dead to us in every other domain of human thought. Though every phenomenon of the physical world belongs to the im-

PLATE II.



THE IRVING PORTER CHURCH MEMORIAL TELESCOPE OF THE FUERTES OBSERVATORY OF CORNELL UNIVERSITY, ITHACA, NEW YORK.

mediate past by the time we perceive it, we have here a unique experience, without parallel in the physical sciencs. It is true that the brain of a Newton or of a Shakespeare still lives for us in the printed page; the hand of Guido Reni, and the beautiful girl he painted in the portrait of Beatrice Cenci, will live till his colors and canvas disintegrate. "Non omnis moriar," wrote Horace, truly. But still these are fixed, lifeless, unchanging memorials; the skeleton of the dinosaur can never move again, nor Reni add a stroke to the portrait; we see no process of the distant past actually going on,—except in such photographs of distant stellar realms. Here we have temperature, light, energy, of the remote past functioning before our eyes; flames thrice as old as those which played on Abraham's altar leap, living, before our living eyes. The past is brought to the present; the present of such distant stars is in our future ten thousand years hence; perhaps those who believe in relativity may draw comfort from such truths!

It is possible that we may thus penetrate much further into past aeons. There is some evidence for the theory that our Milky Way may have its stars arranged in spiral whorls. Certainly its general structure seems closely similar to that of the spirals, and there are many who believe that these beautiful objects are separate galaxies of stars, other Milky Ways, quite certainly much like our own in shape and size, and, like it, composed of billions of suns, but so far away that we cannot distinguish the individual stars. In that case the spirals are at distances of the order of a million light-years, and it is possible that phenomena coeval with our remoter geological epochs are here displayed for us, in the present tense.

In treating of the tremendous extent of the accessible portion of this universe of which we form so insignificant an atom, I have indirectly referred to enormous intervals of time as well. It is impossible to go into details, but the fact should here be emphasized that the time element of our universe is probably no less vast than its spatial features. It seems fairly certain that the life of a star like our sun must be a matter of billions, perhaps trillions of years.

All this leads up to, and leaves but little space for, the theme of this address. I make no attempt to treat of the separate details in the remarkable march of astronomical discovery during the past three centuries, nor pretend to deduce the effect of each upon the totality of modern thought and belief. Even should I try to do so, those who follow other lines of scientific endeavor might object with reason that the progress achieved in other sciences has had equal or greater effect in forming that complex which we may term the modern view-point.

But I think that it may safely be said that astronomy, more than any other science, has operated, especially in its more recent aspects, to change man's ideals from the geocentric and anthropocentric, and to force upon him a proper conception of his true place in the universe.

That this place, so far as present knowledge goes, is apparently a very subordinate one need cause us no concern. It is futile at present

to speculate on the interesting question as to whether or not there may exist at some other point in this vast cosmos conditions of light, warmth, moisture, and material, adequate to permit the birth of life as we know it, and the development of that intelligence which we think we possess. It is certainly not impossible that such life may exist elsewhere; we do not, perhaps can never, know. On the other hand, that wonderful reaction we call life is apparently an absolutely unique phenomenon; it has perhaps started but once in the billion or more years that mark the span of life of our planet; it seems equally possible that there may have never arisen elsewhere that precise and wonderful concatenation of conditions sufficient to give the start to a living cell.

In the latter case we are the only structures of our sort, somewhat puzzled at our loneliness in it all, and still not too certain as to the precise rôle we are destined to play in the Great Plan. The influence of astronomy upon modern thought is thus not without its element of humility, of the self-abasement proper to seventeen hundred million microbes living, loving, and hating upon that mote in the sunbeam we call the earth.

But the influence of astronomy upon modern thought is full of elements of exaltation as well as of humility, of enlargement of soul as well as of pessimistic indifferentism. We leave behind the earth and man as the centers of the universe. A new philosophy takes its place, and there are few of us who are not made bigger and better of soul through the conviction of participation in so mighty a structure as is that given by modern astronomy's picture of the visible universe. Religion, philosophy, and science alike have been enriched by the indispensable element of a vast and all-embracing continuity. Instead of reasoning from man and the earth to the universe without, we are approaching the truer view-point which shall eventually explain infinitesimal man in terms of and in accordance with the laws of the universe.

More important even than this more accurate and universal new view-point in scientific thought is its spiritual effect; I use the phrase with design and offer no objections if some prefer to connote it by the term,—religious influence. Many men, many minds. To some the tremendous interplay of physical forces in our visible universe may seem like purely materialistic phenomena or, at best, as a manifestation of a blind and impersonal theism. Mere size is not necessarily a concomitant of the wonderful; that which is vast may be, as we have seen, relatively simple. I think it was Whitman who said,—"The hair on the back of my hand is miracle enough for me." There are doubtless more wonders, pretty certainly greater complexity, in the substructure of the atom or in the chemistry of the living cell, than in the Milky Way. My own deliberately formed judgment, purely personal, not susceptible of proof perhaps, nor requiring the assent of the reader thereto, is that so tremendous a cosmos must have divinity in it or over it; my reason rebels at the assumption that it is purely materialis-

tic, the result of the chance concatenation of self-created physical forces.

But, whatever our view-point, the influence of astronomical knowledge is certainly toward an exaltation of soul. Whatever our place and purpose in this universe, whatever may be our school of belief, all modern thought has been tempered, changed, and enriched through the knowledge that we are all members of an organization so wonderful, so unthinkably great, that we can not go far wrong in applying to it the adjective divine.

Cornell University and its Department of Engineering are to be congratulated on the acquisition of the fine instrument which is being dedicated tonight as a memorial to a great teacher, and as a tool for instruction and further research. May this fine tool have a long and useful life, and may it, like other tools created by man's brain, react upon that brain to the further inspiration of our souls through service in extending the present limits of the science of astronomy.

OCCULTATION OF ALDEBARAN 1924 FEBRUARY 13-14.

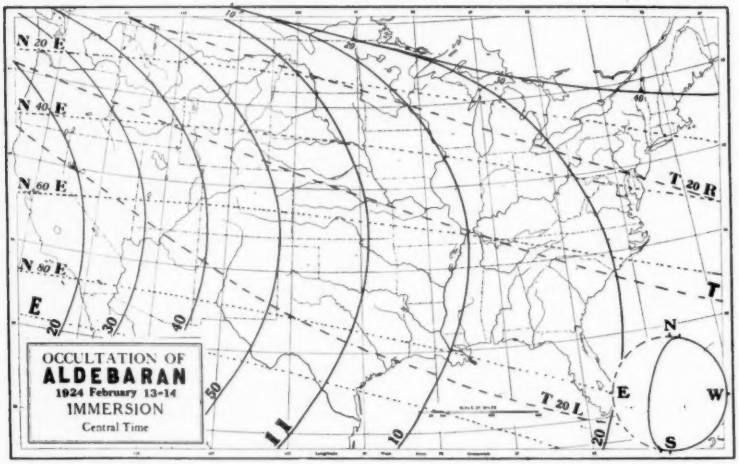
By WILLIAM F. RIGGE.

We are now in the midst of the shower of occultations of bright stars and planets. After a drought of ten years the shower began with Aldebaran 1922 September 13. By the end of 1923 this star has been occulted seven times, and Venus and Saturn once, making a total of nine occultations in 16 months visible in the United States. Nine more will occur before the middle of February of next year, six of Aldebaran, and one each of Mercury, Venus, and Regulus. The list is as follows:

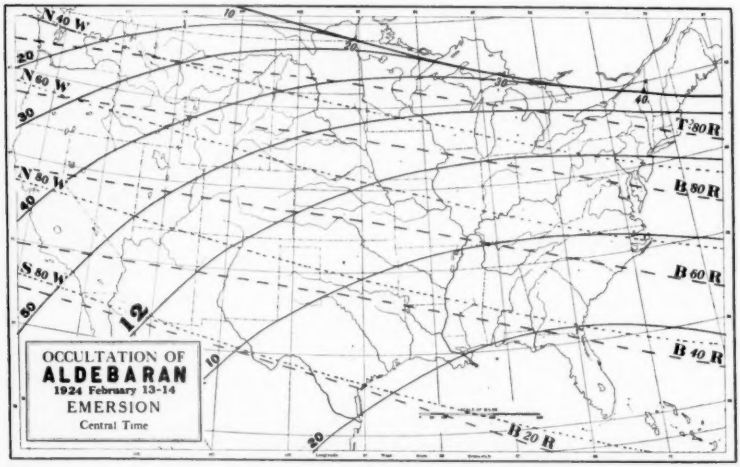
1.	1922	September	13	Aldebaran	10.	1924	February	13-14	Aldebaran
2.		December	3-4	Aldebaran	11.		April	8	Aldebaran
3.	1923	January	13	Venus	12.		June	29	Aldebaran
4.		January	27	Aldebaran	13.		August	2	Mercury
5.		April	19	Aldebaran	14.		August	26	Venus
6.		July	10	Aldebaran	15.		September	19	Aldebaran
7.		September	3	Aldebaran	16.		October	23	Regulus
8.		September	12	Saturn	17.		November	12	Aldebaran
9.		November	24	Aldebaran	18.	1925	February	2	Aldebaran

With the occultation of Aldebaran 1925 February 2 the shower will end as abruptly as it began. No other bright object will be occulted during the the whole of next year.

The occultation of Aldebaran of next February 13-14 has all the good qualities that an amateur could desire for it except most probably the time of its occurrence, which may suit the western states but is rather late for the eastern ones. The Moon's phase is less than a day and a half past the First Quarter, so that the immersion will take



place at the dark limb. The north end of its terminator is 9° 35′ west of the north point. The full lines on both maps indicate the time in intervals of 10 minutes, the large 11 and 12 meaning 11 and 12 P. M. Central Time. The dotted lines give the position angles on the Moon's disk as measured from its cardinal points N, S, E, W, while the dashed lines measure them from its top, bottom, left, right, T, B, L, R. The numbers 10, 20, 30, 40, on the Northern Limit curve show the minutes after 11 P. M. at which the grazing contact will occur in N 10° W.



THE FREQUENCY OF TOTAL ECLIPSES OF THE SUN AT A GIVEN PLACE.

By WILLIAM F. RIGGE.

We may put it down as a fact, that whenever an eclipse of the Sun occurs at any place, the astronomer there is sure to be asked, especially by the representatives of the press: "Does an eclipse of the Sun ever become total here? How often does that happen? When will it happen next? When did it happen last?" These questions are obviously more easy to ask than to answer

In order to obtain some certainty in this matter in regard to one place, at least, the writer started to investigate the magnitudes of all the solar eclipses which would be visible in Omaha for the next two centuries or had been visible there for the last two, the paths of which came so near this place as to hold out hope of their being or having been total or annular or nearly so.

Oppolzer's immortal work, *Canon der Finsternisse*, was, of course, taken as a guide. But as his eclipse tracks are only approximate, except in their sunrise, noon, and sunset points, a mere inspection of his charts is not sufficient even when the track runs accurately through the place in question or comes very near it. A special investigation is therefore necessary for each eclipse. A graphic plot is here the most expeditious, and gives also all the accuracy desirable, that is, the obscuration to the hundredth of the Sun's diameter (or even to the thousandth), and the time to the nearest minute.

The investigation was carried out to the limit of Oppolzer's book, that is, to the year 2161. It was then extended backward as far as the year 1560. During these six centuries the following large solar eclipses were visible in Omaha or will be so. Here T denotes a total eclipse, that is, one that is total on its central line, and A similarly an annular one.

Thefollowing list includes 20 eclipses with magnitudes exceeding 0.70. Not one of them is really total in Omaha, or has the magnitude 1.00. Only one is truly central, the one of 2048 June 11, which is, however, annular, and is visible as such a few minutes after sunrise, the width of the annulus or ring being 0.075 of the Sun's semi-diameter. The first on the list, 1717 October 4, which is marked as both total and annular, proved to be the most interesting. The first graphic plot, which was drawn to the usual scale, seemed to indicate a central eclipse. And as Omaha was very near the noon point of the track—only 30 minutes away—the hope ran high of its having been really total. The scale was then enlarged, first ten, and then a hundred times, and the radius of the shadow on the Earth's surface computed. This last was found to be 0.000238 and its center distant 0.00288, in

terms of the Earth's radius as unity. This means that the diameter of the shadow was about 4 miles and that its center came within about 23 miles of Omaha.

LARGE SOLAR ECLIPSES VISIBLE IN OMAHA BETWEEN 1560 AND 2160.

	Date			Kind	Central Time	Mag.
1.	1717	October	4	TA	11:43 A. M.	0.985
2.	1806	June	16	T	9:24 A. M.	0.93
3.	1811	September	17	A	12:37 P. M.	0.86
4.	1834	November	30	T	12:29 P. M.	0.956
5.	1854	May	26	A	4:17 P. M.	0.77
6.	1869	August	7	T	5:06 P. M.	0.964
7.	1878	July	29	T	4:26 P. M.	0.86
8.	1918	June	8	T	5:26 P. M.	0.86
9.	1925	January	24	T	Sunrise	0.87
10.	1954	June	30	T	Sunrise	0.966
11.	1994	May	10	A	10:39 A. M.	0.86
12.	2017	August	21	T	12:12 P. M.	0.950
13.	2048	June	11	A	Sunrise	0.962
14.	2099	September	14	T	9:34 A. M.	0.84
15.	2100	March	10	A	Sunset	0.71
16.	2106	May	3	T	12:10 P. M.	0.74
17.	2111	August	4	A	1:06 P. M.	0.87
18.	2121	July	14	A	9:22 A. M.	0.88
19.	2153	October	17	T	9:45 A. M.	0.89
20.	2154	April	12	A	4:17 P. M.	0.86

To the questions put down at the beginning of this paper the writer can now return this partial answer:—that no total eclipse whatever was visible in Omaha during the past four centuries, and none will be visible for the next two. To extend this investigation beyond these limits would call for a more potent motive than the mere satisfaction of knowing the answer.

The results here obtained for Omaha do not apply, as they are, to other places. For each of these a similar investigation must be instituted. The labor is thus very great, and an astronomer has therefore a good reason to decline it.

Our inborn curiosity, however, will not be satisfied. It craves to know whether such an investigation has never been instituted at all for some place or other on Earth, so that we may have some idea of the frequency of total eclipses of the Sun at one place, at least. Fortunately for our case, the recent work of J. Fr. Schroeter, *Sonnenfinsternisse von* 600 *bis* 1800 *n. Chr.*, comes to our aid. This gives excellent maps of all the solar eclipses whose central lines lay across some part of Europe between the years 600 and 1800 A. D. Not to mention the accompanying numerical data and the corrections to Oppolzer's, our labor is much lessened by the fact that the principal cities all over Europe are marked on the maps. Taking Rome, therefore, as an instance, we find that during these 12 centuries it was privileged to see only two total solar eclipses, 968 December 22 and 1386 January 1. It was near the southern border of the track in the first case, and near the northern in the second. Eleven total eclipses came near the place.

Only two annular eclipses were visible, 698 December 8 and 753 January 9, the first being nearly central. Six annular eclipses came close. In 1567 April 9 there was a total-annular eclipse. This was most probably total in Rome, because it was central there and the time was very near noon. During these 12 centuries, therefore, Rome saw only one central total eclipse, and this was of short duration.

In like manner London was favored with only two total eclipses, 878 October 29 and 1715 May 3, being near the southern border of the track in both instances. Nineteen such eclipses came near the place. Four annular eclipses occurred, 698 December 8, 852 March 24, 934 April 16, 1290 September 5, the third and fourth being central, the second nearly so, and the first not central. Eighteen annular eclipses were just missed.

Rome, therefore, saw three total eclipses of the Sun in 12 centuries and London two. This statement must satisfy us for the present as to the frequency of such eclipses at a given place.

A NEW PRISM TRAIN FOR NEBULAR SPECTROGRAPHS.

By O. H. TRUMAN.

The spiral nebulae are very faint objects, and, because of their continuous spectrum, the little light they give is so spread out on the photographic plate by a spectrograph that very long exposures, even running into days, become necessary; and even these give disappointingly weak impressions. If investigation of these important objects is to continue, it seems indispensable that some improvements on present optical facilities shall be made.

It is well known that the speed of a spectrograph used with a telescope to photograph the spectrum of a luminous surface depends primarily upon only two factors—the light loss in the optical train between the slit and the photographic plate, and the aperture ratio of the camera lens. I will describe in this paper a prism train by which the light loss before reaching the camera lens is reduced so as to be much less than heretofore possible in instruments of equal power; and in a later paper a new camera lens which saves an additional amount of light, and is of very great aperture ratio as well.

As shown in Fig. 1, the prism train consists of two prisms with spherical surfaces, so arranged as to do away with the need of a collimating lens. As a collimating lens must lose at least 11 per cent of the light by reflection alone, it is apparent that this system effects an initial saving of more than that amount.

The angles and dimensions here given are for the glass made by Schott und Gen. and designated by them as "Ordinary Flint O_{118}." It was chosen because when the computations were made, six years ago,

it seemed to combine in the highest degree of any glasses then existing sufficient dispersive power with unusual transparency in the photographic region of the spectrum. It is possible that still better glasses have since been produced. The rays whose paths are drawn are of λ 4300, intended to be the central rays of the spectrum.

Light coming from the slit, in the direction of arrow S and diverging at a ratio of 1 in 15, passes thru the first surface perpendicularly and without dispersion, as the center of this surface is at the center of the slit. The distance from the center of the slit to the center of the second surface being taken as 100, the angles and dimensions are as follows:

	°	′	″
ϕ_1 =	33	38	41.8
θ_1 =	65	0	0.0
ϕ_2 =	40	45	0.0
θ_2 =	23	31	6.7
ϕ_3 =	28	34	57.2
θ_3 =	51	30	0.0

t_1	6.87
t_2	2.58

Radii

1st	surface	R_1	97.67
2d	"	R_2	105.14
3d	"	R_3	1014.95
4th	"	R_4	122.79

The emergent rays are slightly divergent, as if from a very distant point source.

The special methods of computation devised for removing the aberrations would occupy a prohibitive amount of space. Some general considerations in the design and comparison with previously used systems may, however, be recounted.

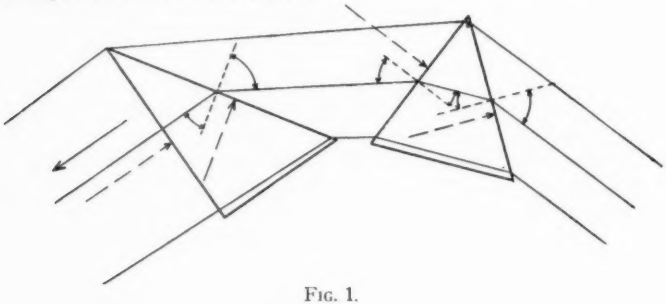


FIG. 1.

It is desired to have as great a dispersion on the plate as possible without undue sacrifice of other needs. But to secure a high linear dispersion requires either large focal length of the camera lens or high angular dispersion in the prism train. If the camera lens be made of considerable focal length, then with the necessary great aperture ratio its absolute aperture will also be large. This necessitates great size of

prisms, which is disadvantageous alike because of the difficulty of securing large blocks of glass of sufficient homogeneity, the larger surfaces to figure, and the greater loss of light by absorption. On the other hand, if high angular dispersion is sought, more prisms must be used, with excessive loss by reflection at their numerous faces. And, finally, the longer the spectrum the less its intensity.

The system above will give, with a camera lens of 100 mm. aperture and focus, a linear dispersion of 138 A per mm. at λ 4300. To obtain the same dispersion with a collimating lens and one prism, according to the old method, would be quite out of the question, because of the immense prism required. But with two prisms it could be managed. Assuming them to be made of the same glass as used above, O_{118}, and making their refracting angles 67° 18′, the aperture and focus of the camera lens would need to be 55.4 mm. With this size aperture the refracting faces of the prisms would be 131 mm. × 56 mm. and the bases 145 mm. × 56 mm., which is probably not excessive. But it can be easily computed that the prism train would let through only 49 per cent of the light falling upon it; and if we reckon the loss in the collimator as only 12 per cent, it follows that only 43 per cent of the light passing through the slit reaches the camera lens. On the other hand, with the above spherical surfaced system, the size of the prisms to be made is less, while 65 per cent of the light escapes loss. Thus the new system is about 50 per cent more efficient than one which can be fairly taken as representing its predecessors; and the former will accomplish in a ten hour exposure as much as the latter in fifteen hours.

It is seen in Fig. 1 that the beam emerging from the prisms is narrowed in a direction perpendicular to the spectrum lines to about half its original width. This is a great advantage, as making the requirements on the camera lens less severe, and as effecting some additional gain in illumination.

That such a gain results may be seen by considering that a circular beam falling upon the first surface would issue from the fourth surface in roughly elliptical form, so as to be more than accommodated by a circular lens. Hence a beam somewhat larger than a circle, approaching a square form on the front surface, would still be entirely utilized. If this fact is taken advantage of, there results an additional gain of about 20 per cent over that already attained, so that the entire gain over preceding forms may be put at 80 per cent.

This narrowing of the beam can be carried still further, if desired, though to do this the angle of incidence on the first surface would probably have to be made different from zero, and the computation would be more involved. The loss of resolving power is, of course, of no consequence, as the optical resolving power will in any case far exceed the photographic.

As a final test of the quality of the imagery a large number of rays, not only from the center of the slit and in the meridian plane, but from the ends of the slit and outside the meridian plane, and of different

wave lengths, were traced through by trigonometry, a suitable modification of Seidel's formulae being used. It was found that the residual aberrations were not great enough to be material.

4134 Fourth St., San Diego, Calif.
June 26, 1923.

NOTE ON THE ECLIPSE OF SEPTEMBER 10, 1923.

By JOEL STEBBINS.

In common with other expeditions to the Pacific Coast, the one from the University of Wisconsin was disappointed in having a cloudy sky on September 10. Our party consisted of Dr. Jakob Kunz from the University of Illinois, Mr. O. E. Romare, mechanician of the University of Wisconsin, and myself; also as volunteer assistant, Mr. W. R. Jewell of Danville, Illinois. We located on Catalina Island, just one the outskirts of Camp Wrigley, the Yerkes station, and with others shared the advantages of being neighbors of this large and complete expedition.

Our proposed program consisted of a repetition of the photo-electric measurement of the total light of the corona with the same apparatus used by Mr. Kunz and myself in Wyoming at the eclipse of June 8, 1918. Since at the previous time the sun-spots were near the maximum, and in 1923 near the minimum, a measure at the second eclipse would have been under the most favorable conditions for detecting variation in the total light of the corona during the sun-spot cycle. Preliminary tests in Madison gave practically the same value for the light of the full moon, in terms of our standard lamps, as we found in 1918, and with the favorable prospects of a good sky we hoped to get even better measures than we had secured in Wyoming.

The apparatus was installed in a small hut, of much the same character as we had before, and the dry air on Catalina was apparently as favorable to the performance of photo-electric cells as was the desert air at Rock Springs. The galvanometers were beautifully steady, and we had two potassium cells in readiness the success of either one of which would have given a measure strictly comparable with the results of five years previous.

Although it had been obvious from the dawn of September 10 that there was little chance of success, it was determined to go through with the program if for no better purpose than to have the practice for the next eclipse. About five minutes before second contact the crescent sun made a bright spot in the clouds, and the photometer tubes were pointed at the proper place for mid-totality. At the signal "Go" given by Dr. H. C. Wilson for all the parties, we exposed our cells to the hypothetical corona, Mr. Romare operating the tubes, and Messrs.

Kunz and Stebbins reading the galvanometers every ten seconds throughout totality. It was a dismal task to record the small variations of the readings, there being apparently no difference whether the cells were pointed at the eclipsed sun or toward the sky eight degrees north of the sun; and even when the tubes were covered, which was twice during the 168 seconds, exposure to dark seemed also to make no difference. I myself glanced upward through a skylight twice during totality and saw only a uniformly clouded sky in the neighborhood of the sun.

A graph of the recorded readings, however, shows that both observers had faithfully carried out the program, as the zero dark readings for both instruments were distinctly marked. Averaging up the deflections during the entire time, there is found for No. 1, Mr. Stebbins, 1.04 scale divisions, and for No. 2, Mr. Kunz, 0.57 scale divisions. Expressed in terms of unity of our standard lamp N1 at one meter this gives 0.021, exactly the same for both observers, No. 1 being the more sensitive installation. This agreement was more or less accidental, as we might have expected a discordance of ten or twenty per cent between the two results from such small deflections.

For comparison with the eclipse observations, measures had been taken of the clear sky eight degrees from the sun at about the same hour on September 9. Reduced to the area of a circle four degrees in diameter—the effective field used during totality—the sky gave 79.4 in the same units as above. We have then that the reduction of the sky intensity during totality was 79.4/0.021 or 38,000-fold as compared with the clear sky. This measure was in the blue light to which the potassium photo-electric cell is sensitive. The corresponding figure for the sky without clouds in 1918 was about 6,000, so that the clouds at Catalina cut down the general light of the sky several times, but perhaps not as much as one might have expected. This is the only result that we secured, and it amounts to about as near a cipher as can be represented by figures.

The expedition was made possible by grants from the Research Committee of the University of Wisconsin, and the Committee on the Watson Fund of the National Academy of Sciences.

Washburn Observatory,
Madison, November, 1923.

THIRTIETH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 661, Vol. XXXI.)

THE EFFECT OF THE SUN ON THE MAGNETS.

By Luis Rodés.

The paper deals with the principal facts established at Ebro Observatory after a simultaneous registration of sun-spots in the magnetic activity extending over a complete solar cycle.

Taking advantage of the favorable location of the observatory special attention has been given to the magnetically calm days. It has been found that: (1) The number of quiet days is very much greater in the years of minimum than in the years of maximum solar activity; there were in round numbers 200 calm days in 1912-1913 and only 42 in 1916. (2) The disturbed days have very conspicuous maximum during the year 1919 and a minimum around 1912-1913. (3) The mean range of the diurnal variation in all the calm days during the year has its greatest value at the time of maximum solar activity; the mean diurnal range in declination was about nine and a half minutes during the last maximum in 1917 and only six and a half minutes at the time of the minimum in 1912. That shows that the influence of the sun on our magnets is not restricted to the stormy days. (4) The distribution of calm days and stormy days along the year shows that both are dependent on the position of the earth with respect to the solar equator; the number of calm days having a conspicuous minimum around the time in which the earth is crossing the solar equator, and the stormy days on the contrary clustering around the same epoch.

In the last solar cycle there have been some 30 spots, the area of which surpassed one thousandth of the visible hemisphere; of these only twelve were very probably connected with magnetic storms.

There have been very conspicuous sun-spots which had no appreciable effect on our magnet; that might be explained either by the different angle at which the sun projects the electrical particles into space or by the different polarity of spots. In order to test this last hypothesis, the polarity of 250 very definite spots was examined by the writer during his sojourn at Mount Wilson Observatory and then studied in connection with the magnetic records at "del Ebro," but so far no definite statement can be made besides the general one that the complex and the very irregular groups are the most active.

As the curves measuring magnetic activity are in general of the same period and shape as the ones measuring the area and the frequency of sun-spots, we may conclude that both phenomena are closely related either by the relation of cause and effect or by a double effect proceeding from an unknown cosmic cause.

There have been great magnetic storms without any proportional disturbance on the sun's atmosphere, but as the number of magnetic

storms is dependent on the position of the earth with regard to the sun, it seems probable that even in the case of an extra-planetary cause acting upon the sun and the earth the former is directly responsible for the magnetic disturbances on our planet.

In connection with the conclusion arrived at by Dr. Louis A. Bauer that magnetic activity is chiefly related to the variation of solar acivity, it may be of interest to bear in mind (1) that the greatest magnetic storm on record in "del Ebro" Observatory (the one of May 13, 1921), was related to the sun-spot which remained pretty constant during those days and (2) that the greatest development of an area of disturbance on the sun (the one of August 18, 1916) which, in less than forty-eight hours, involved an area of more than one thousandth of the visible hemisphere, produced but a small perturbation which began August 22, at $18^h\ 25^m$.

An investigation is being made by the writer to detect the way in which magnetic storms are propagated; the data so far collected point towards a propagation which could be explained by the entrance of our planet into a kind of electric cloud projected away from the sun, that observatory being first struck which, taking account of the diurnal rotation, happens to be in front with respect to the annual orbit.

ON THE ORBIT OF THE BRIGHTER COMPONENT OF β LYRAE.

By R. A. Rossiter.

The β Lyrae system has been found to be a simple two body system. A study of the orbit of the brighter component has shown that the center of mass velocity is a constant and that elliptical motion is unusually well satisfied. The study has been based on 442 Ann Arbor spectrograms and on Professor R. H. Curtiss' Allegheny results, representing a total interval of fourteen years. A strongly marked limb velocity effect has been noted and measured. It is due to the velocity of rotation of the uneclipsed limb of the brighter component during the time of eclipse and increases the measured radial velocity due to orbital motion by a maximum amount of thirteen kilometers. This effect should be measurable in all β Lyrae and Algol type binaries.

SOME VAGARIES OF REFRACTION.

By Arthur J. Roy.

Results of the circumpolar observations made at San Luis demonstrate that the Pulkova Refraction Tables can not be adapted to other stations for all zenith distances by simply using a factor. This is shown by contrasting the O — C of the two solutions, the first of stars within eighteen degrees and the second within twenty-six degrees of the pole. A second table gives the smoothed corrections to the Preliminary General Catalog when these two solutions are extended to all zenith distances observed.

Selected consecutive series from the Albany observations illustrate the irregular variations of the refraction factor.

	To 72	All
—88°	—0".23	—0".12
87	—0.02	—0.13
86	—0.01	—0.11
85	—0.14	—0.05
84	—0.08	—0.15
—83	—0.13	—0.19
82	—0.06	—0.01
81	—0.14	—0.17
80	—0.18	—0.19
79	—0.03	—0.01
—78	—0.03	—0.07
77	—0.06	—0.01
76	—0.25—	—0.37
75	—0.19	—0.36
74	—0.08	—0.29
—73	—0.23	—0.04
72	—0.06	—0.38
71	—0.27	—0.14
70	—0.25	—0.24
69	—0.58	—0.01
—68	—0.96	—0.26
67	—0.95	—0.11
66	—1.26—	—0.26
65	—1.58	—0.38
64	—1.71	—0.26

Resulting corrections to P. G. C.

—90°	—0".01	—0".04
80	—0.02	—0.18
70	—0.03	—0.28
60	—0.15	—0.53
—55	—0.35	—0.77
50—	—0.37	—0.82
45	—0.34	—0.82
40	—0.25	—0.75
—30	—0.14	—0.71
20	—0.05	—0.67
10	—0.03	—0.65
0	—0.04	—0.72
—10	—0.02	—0.87
20	—0.05	—1.04
30	—0.08	—1.27
40	—0.11	—1.74
—50	—0.09	—3.38

Albany Series	Late P. M.	Early Night
=772	0.9963	1.0091
773	0.9976	1.0058
774	1.0046	1.0044

=772, May 11, 1916

10.2 hrs.	0.9961
10.8	0.9978
11.7	1.0081
13.0	1.0100

ATMOSPHERIC PULSATION OF CEPHEIDS: A METHOD OF ATTACK.

By W. Carl Rufus.

A new method of attacking the problem of Cepheid variation is proposed. The radial velocities of concentric atmospheric layers may be determined separately by selecting lines of the spectrum originating at different heights. The velocity differences plotted against phase represent systematic relative motion of the layers with accompanying expansion and compression of the atmospheric gases. Resulting periodic changes in temperature, density, radiation and absorption may be correlated with the light variation and change of spectrum. A lag of phase of the upper layers accounts for the retardation of the time of light maximum.

Preliminary results on S Sagittae by Mr. J. A. Aldrich and on η

Aquilae by the writer prove the practicability of the method. Material on hand in the various observatories may be used as a further test. The method is applicable also to long-period variables and to other astrophysical problems.

THE ATMOSPHERE OF THE SUN AND RELATIVITY.

By Chas. E. St. John.

A few years ago the pressure in the reversing layer of the solar atmosphere was thought to be equal to 6-7 terrestrial atmospheres. Recent investigations have shown that this interpretation of the differences between solar and terrestrial wave-lengths is not valid. The pressure coefficients per atmosphere of the iron lines of groups *a*, *b*, *c*, and *d* increase from group to group. In the same spectral region the differences, solar wave-length minus vacuum wave-length, should be greater, the larger the coefficients of pressure provided the pressure in the sun is measurably greater than zero. For example: (the increase in the solar wave-length of *d* lines *minus* the increase in solar wave-length of *a* lines) ÷ (coef. *d* — coef. *a*) = pressure in atmospheres.

Some preliminary results are as follows:

Groups	Region	No. of Lines	Pressure in Reversing Layer
a — *b*	3800	41	— 1.0 atmosphere
a — *b*	5050	92	+ 0.9 "
b — *d*	4100	62	+ 0.5 "
b — *d*	4550	37	— 0.2 "

As the deduced pressures oscillates about zero, it is concluded that the pressure is at most only a small fraction of our atmosphere.

The solar atmosphere extends to a height of about 15000 km but nearly all the mass is concentrated at the bottom within a shell 100-300 km thick where the pressure is but a small fraction of an atmosphere. The pressure at 5000 km is given by Saha at 10^{-4} atmospheres and at the H and K level Fowler and Milne estimate it as of the order of 10^{-13} atmospheres. In the outmost level the atmosphere consists of ionized calcium. To this is added at lower levels hydrogen, helium, magnesium, sodium, normal calcium, ionized titanium, iron, until at the photospheric level it contains all the elements found in the sun. The pressure is that of a partial vacuum, the temperature approximately 6000-degrees centigrade and the convection currents have velocities of 1000 miles an hour.

The absence of appreciable pressure in the sun's atmosphere increases greatly the data available for the investigation of gravitational displacement of solar lines, and simplifies the problem by eliminating from consideration both pressure shifts and anomalous refraction, as the latter demands high density gradients. The present study is based

upon between three and four hundred iron lines for which the wave-length in vacuum, at one atmosphere and in the sun, are known with high precision. The solar wave-lengths at the center of the disk are longer than the wave-lengths in vacuum. When the calculated gravitational displacement is applied to these differences there remain residuals much larger than the probable errors of the data. These residuals are systematic and vary with the levels of the effective absorbing layers from + 0.004 A for the high level or strong lines to — 0.003 A for the lower level lines. For example:

Groups	No. of Lines	Intensity	Region	Calculated	Observed	Obs.—Ca	Required velocity
a	17	12	3826	0.008	0.012	+ 0.0040	+ 0.3 km down
a	10	6	5419	0.0115	0.0112	— 0.0003	0.0
a	33	3.3	4957	0.0105	0.0074	— 0.0031	— 0.2 km upward

Similar results are given by the lines of group *b*. These residuals can be accounted for by a downward drift of 0.3 km/sec. at high levels and an upward current of 0.2 km/sec. near the photospheric level and a balanced state in the intermediate levels. The magnitude of the currents necessary to bring the calculated displacements into agreement are cosmically not large but their continuous existence offers some difficulties to be discussed in extenso later. The total observed displacements to the red can not be attributed to downward velocity, as the wave-lengths at the limb would tend to be shorter, while in fact they are longer. They can not be assigned to pressure nor to anomalous refraction. Anomalous refraction requires higher density-gradients than the very low pressure justifies and moreover Julius deduces that the strongest lines should be displaced least, while in fact their displacements are greatest of all.

Considering the situation as I now see it, displacements predicted by general relativity combined with small Doppler displacements offer the most probable interpretation of the differences between the wave-lengths at the center of the sun's disk and in the arc in vacuum.

There remains to be considered the further displacements to the red at the edge of the sun's disk. The increased length of the path at the limb through layers supposedly under great pressure was the explanation suggested by Halm, Fabry and Buisson, and Adams, but this explanation is no longer tenable with maximum pressures of small fractions of an atmosphere.

The theory of dispersion requires that the refractive power of a medium should increase rapidly as an absorption line is approached from either side. Professor Julius has called attention to the fact that the resulting refraction power is greater on the red than on the violet side of the absorption line by twice the refractive power of the atmosphere. He ascribes the displacement between center and limb to an asymmetry which he says depends upon anomalous refraction and scattering in high irregular density gradients. Aside from the consideration that persistent irregular density-gradients are improbable,

the very low pressure at the bottom of an atmosphere thousands of kilometers deep would indicate that steep pressure gradients, if they do occur, are limited to exceptional solar conditions. There remains the effect of molecular scattering in accordance with the Rayleigh-Schuster formulae. The excess of refractive power on the red side of an absorption line results in differential scattering acting to widen the line on the red side. The substitution of differential scattering for pressure would make the arguments of Halm, Fabry and Buisson, and Adams again valid.

The conclusion is that three major causes are at work in producing the regular differences between solar and terrestrial wave-lengths, and that it is possible to disentangle their effects; namely the slowing of the atomic clock in the sun to the amount predicted by the general theory of relativity, radial velocities of moderate cosmic magnitudes and of probable directions, and differential scattering in the longer paths traversed by the light coming from the edge of the sun.

RADIAL VELOCITIES OF STARS OF SPECTRAL CLASS R.

By R. F. Sanford.

Stars of spectral class R were at first included with stars of class N and do most resemble them. The outstanding bands and groups of lines in both classes of spectra, are ascribed to carbon compounds, while the striking difference between the two types lies in the relatively greater amount of blue light in class R stars which makes for a greater extension of the spectrum toward shorter wave-length, and for a smaller color index, though the difference between a late type R and an early type N is not very marked. Evidence put forward by Rufus, R. H. Curtiss and Merrill seems to point to the conclusion that the stars of these two classes form a branch of stellar sequence breaking away from the main sequence B, A, F, G, K, M at about G and proceeding in the order R, N.

Between sixty and seventy stars of this spectral class are known scattered over the whole sky. Radial velocities of 10 of these were determined by Rufus at the Observatory of the University of Michigan. Further observations at Mt. Wilson, mostly with the use of the 100-inch reflector and a one prism spectrograph, have made possible the determination of radial velocity for twenty more and the checking up of these previously determined. A list of the velocities for these thirty stars was shown. There are three outstanding ones, as follows:

Name	Velocity	Type
B.D.+23° 123	−234 km/sec.	R3
B.D.+20 5071	−383 " "	R3
B.D.− 3 5751	−136 " "	R0

Though the material of these thirty radial velocities is scant it has been used to derive some idea of the solar motion as referred to them.

This was treated in two ways (*a*) all stars were used and (*b*) the three large ones mentioned above were omitted.

The results are:

Solution	A_0	D_0	V_0	Arithmetical Mean Residual Velocity
(*a*)	350°	+ 23°	73 km/sec.	55 km/sec.
(*b*)	298	+ 33	21 " "	25 " "

A_0 and D_0 are right ascension and declination of the solar apex and V_0 the speed of the sun. The last column gives the arithmetical mean of all the velocities after they have been freed from the solar motion. The values of solution (*b*) compare favorably with the usually accepted values $A_0 = 270°$ $D_0 = +30°$ $V_0 = 21$ km/sec.

There are proper motions by Dr. R. E. Wilson for 18 stars of this group; again very scanty material. However the combination of proper motion and radial velocity material led to the derivation of a mean parallax + 0″.00105. The mean apparent magnitude is 8.43; whence by the well known formula

$$M = m + 5 + 5 \log \pi,$$

the mean absolute magnitude turns out to be — 1.5.

Proper motions and radial velocities for the first two of the three stars listed above combined with the derived mean absolute magnitude give evidence that these stars are moving with reference to the sun in the same general direction in the plane of the galaxy, which studies made by Adams and Joy and Strömberg seem to indicate is characteristic of fast moving celestial bodies of all descriptions.

NOTES ON THE LUMINOSITY FUNCTION.

By Frederick H. Seares.

The constants of the gaussian curve adopted by Kapteyn and van Rhijn for the luminosity function depend on the formula for mean parallax expressed as a function of proper motion and apparent magnitude. Since the mean parallax formula is based in part on the parallactic motions of stars as faint as the eleventh magnitude, it is of interest to know how accurately the luminosity function represents the apparently bright stars whose distances have been measured individually. The density function is also involved, but this relation depends only on the luminosity function and the observed number of stars in each interval of apparent magnitude, which is subject to no great uncertainty.

For the stars brighter than the fifth apparent magnitude it is found that the calculated distribution of absolute magnitudes with allowance for numerous disturbing factors, agrees with the observed distribution as well as can be expected. The chief divergence is an excess in the calculated numbers of stars of high luminosity. This can be in-

terpreted as a systematic difference between the mean parallaxes and individual parallaxes measured by trigonometric or spectroscopic methods, and is of the same sign and approximately of the same amount as the difference recently found by van Rhijn.

It is known that the number of stars of low luminosity among those near the sun is in excess of the number indicated by the luminosity function, but the totals involved are so small that the disagreement can scarcely be accepted as proof of error in the luminosity curve. The above comparison reproduces the evidence on this point, but leaves the question unsettled. An extension of the comparison to stars of the fainter apparent magnitudes would help, but this cannot be done at present because of the selection favoring large proper motions and low luminosities which affects the data for individual stars.

The following test of the applicability of the gaussian error curve seems, however, to lead to positive conclusions. On the basis of gaussian distribution functions for luminosity, density, and the logarithms of tangential velocity it can be shown analytically that, very approximately,

$$\bar{M} - H = \text{a linear function of } H$$

where

$$H = m + 5 \log \mu$$

and where $\bar{M}$ is the mean absolute magnitude of the stars having the apparent magnitude m and the proper motion μ. For stars near the sun, where the treatment must be modified because of the failure of the gaussian distribution function for density, the relation is essentially the same.

If, however, the observed data for stars of known parallax be grouped according to magnitude and proper motion (it is sufficient to consider only stars of large proper motion, say $\mu > 0''.3$ or $0''.4$), the following result is found: The differences $\bar{M} - H$ are a linear function of H for $\bar{M}$ less than 6.5, the coefficients being the same as those derived theoretically. Beyond $\bar{M} = 8$ the relation seems again to be linear. Between these two points the functional relation is more complicated. Beyond the ninth magnitude the linear character is uncertain, but this at least seems definite: 75 or 100 stars of low average luminosity show a definite departure from the linear relation which satisfactorily represents the stars of higher luminosity.

The assumption concerning tangential velocity which underlies the theoretical relation can be justified. The disagreement with observed data must therefore originate in the assumption for the luminosity function. The comparison indicates that for stars on the ascending branch of the curve the gaussian function of Kapteyn and van Rhijn is applicable. For stars on the descending branch, however, another curve is required, which will be gaussian or not according as the differences $\bar{M} - H$ for the fainter stars do or do not bear a linear relation

to H. Although the conclusion depends on the characteristics of only a small number of stars, all of them nearby, it can scarcely be doubted that the luminosity function is a skew curve with a relatively flat descending branch, and that the total number of intrinsically faint stars is really much greater than hitherto supposed.

The efficacy of the method lies in the fact that the data can be *selected and grouped on the basis of proper motion and apparent magnitude.* The excess of larger proper motions among the stars of known distance, hitherto so disturbing a factor, is therefore no obstacle, and *all* the stars of large proper motion and known parallax can be utilized.

The theoretical expression for $\bar{M} - H$ is only another form of the mean parallax formula. Applied to the stars brighter than $\bar{M} = 6.5$. it leads directly to the formula of Kapteyn and van Rhijn. Since the intrinsically faint stars (in general, stars of large μ and m) require a different linear relation, it follows also that the formula representing their mean parallaxes must differ from the formula of Kapteyn and van Rhijn. This conclusion is verified.

THE ASYMMETRY IN THE DISTRIBUTION OF STELLAR VELOCITIES.

By Gustaf Strömberg.

The study of the space-velocities of the stars has shown that there exists an asymmetry in the distribution of stellar velocities, which asymmetry is especially marked among the stars of high velocity. This asymmetry produces an increase of the sun's velocity with the speed of the stars relative to which the sun's motion is referred. This relationship of the sun's velocity to the speed has been found to be a perfectly general phenomenon, which can be found among all classes of stars and is very clearly shown among star-clusters and spiral nebulae.

The general nature of the asymmetry suggests a property due to space itself, and it can be shown that the phenomenon can be explained, if we make the assumption, that there exists a fundamental reference-frame for cosmic velocities. This reference-frame is of such a nature, that excessive velocities relative to this frame for some reason do not exist.

The distribution-law of cosmic velocities can be represented by a product of two frequency-functions, of which one is a sum of concentric, ellipsoidal frequency functions, and the other is a spherical frequency function with its center quite different from that of the first function. The second function represents a "velocity-restriction" in space. The velocity of the sun in this fundamental reference-frame is about 650 km/sec. towards the apex $\alpha = 305°$, $\delta = +75°$.

A NEW CATALOG OF VARIABLE STARS.

By S. D. Townley.

A new "Catalog of Variable Stars" is being prepared by the author of this paper with the co-operation of Harvard College Observatory. A brief history of variable star catalogs was given. A departure from the conventional type of catalog is to be made. Instead of placing all the variables together in one table they will be separated into several tables arranged according to a modified Pickering classification.

The following arrangement gives the tables, together with the number of stars in each, according to the preliminary draft of the catalog.

		Number
Table 1	Novae	51
" 2	Long Period	722
" 3	Irregular	147
" 4	Cepheids	210
" 5	Eclipsing	183
" 6	Faint Orion	153
" 7	Unknown	1508
	Total	2974
" 8	Variables in Clusters and Magellanic Clouds.	

The stars for Table 8 have not yet been enumerated. Both the Argelander and the Pickering nomenclature will be used. The star places will be given for the epoch 1925. The galactic latitudes and longitudes will also be given. It is intended to give all available data concerning each star, proper motion, radial velocity, parallax, spectrum, etc. besides the usual data concerning period, epoch, maximum and minimum magnitudes. It is expected that the catalog will be ready for publication during 1924.

RELATIVITY AS REPRESENTED BY THE EINSTEIN ECLIPSE PROBLEM.

By Robert Trumpler.

The Einstein eclipse problem in its widest sense is concerned with the question: Are light rays influenced by gravitation when they pass near a heavy massive body like the sun, and if that is the case, how much are they deflected from their normal straight path? The effect of gravitation on a light ray originating in a star and passing near the sun would be to make the light ray follow a curved path, a hyperbola. To the observer on the earth the star then appears displaced from its normal position in the direction away from the sun. This apparent displacement is largest for a star seen at the sun's edge, for other stars it is inversely proportional to the angular distance of the star from the sun's center.

As to the amount of these displacements the principal theories of light and gravitation lead to different predictions.

1) Most theories of light before Einstein worked with the assumption that light is not subject to gravitation and does not suffer any deflection.

2) The corpuscular theory of light admits that light is subject to gravitation (Soldner 1801), and to this same conclusion Einstein is led in 1911 by his principle of equivalence. If Newton's law of graviation is adopted, this assumption requires a displacement of 0″.87 for a star seen at the sun's edge.

3) Einstein's generalized theory of relativity of 1916 not only assumes that light is subject to gravitation, but also establishes a new law of gravitation and predicts a displacement of 1″.75 at the sun's edge.

If we speak of Einstein's prediction generally, the last value resulting from his complete theory is meant; the second value is often designated as the half effect.

It is the task of the observer to decide which of these three predictions corresponds to reality. The practical solution of this task consists in photographing the stars in the neighborhood of the sun during a total eclipse of the sun. Another photograph of the same stars is obtained at night, several months before or after the eclipse, when the sun is in a different part of the sky, showing the stars in their normal positions. The two plates are then compared by differential measures, and after these measures have been corrected by calculation for the difference in instrumental adjustment, they give the apparent star displacements during the eclipse.

The first successful observations of this effect were made at the eclipse of May 29, 1919, by two British expeditions. The results of the three instruments used were 1″.98 ± ″.12, 0″.93 and 1″.61 for the light deflection at the sun's limb. The first value based on the best set of plates (four-inch camera of 19 feet focal length) undoubtedly deserves most confidence, and the observations as a whole may be said to be favorable to Einstein's prediction, although one of the results is discordant and agrees better with the half effect.

Our problem was taken up again by the Crocker expedition of the Lick Observatory observing the total eclipse of September 21, 1922, at Wallal on the northwest coast of Australia. Two photographic twin cameras of 15 feet and 5 feet focal length respectively, both equipped with wide angle objectives and mounted equatorially, were specially designed for the purpose of Dr. Campbell. With the 15-foot cameras four good eclipse photographs, each covering a field of 25 square degrees, were obtained; with the 5-foot cameras six plates with a field of 225 square degrees. With all instruments comparison photographs of the same stars had been secured in May 1922 on the island of Tahiti.

The four plates of the 15-foot cameras, of which three were measured independently by Dr. Campbell and myself, gave results for the

deflection of light at the sun's edge of 1".80, 1".48, 1".85, and 1".76. The agreement of the different plates and of the two observers is very satisfactory and the mean result of $1".72 \pm 0".11$ closely confirms the prediction of Einstein's generalized theory of relativity. An average of about 80 stars up to the photographic magnitude 10.5 was measured on each plate. When the radial displacements of the stars are plotted as function of the star's angular distance from the sun's center (extending out to 3°) they also satisfy the predicted law of inverse proportionality. The star closest to the sun that could be measured has a theoretical displacement of 0".85 (19 microns) which is about ¾ of the radius of its image disc on the photograph.

It is important to have a check that these results have not been vitiated by systematic errors introduced by the telescope, the photographic process, the measures or the method of calculation. For this purpose an auxiliary star group was selected, so situated that neither at Tahiti nor at Wallal it could have been affected by the sun's gravitation. All the eclipse photographs and the Tahiti comparison plates had received an additional exposure on this auxiliary group. Each plate therefore contained star images belonging to two different star fields which were measured and reduced alike. The fact that only the stars of the eclipse field showed the displacements proves that they cannot be due to such systematic errors, as these should have affected all star images on the plate in the same way.

Whether the observed star displacements may not a least partly be due to other causes than gravitation, e. g. to refraction in a circumsolar medium, remains an open quesion. All that can be said is, that the close numerical agreement of observations and prediction makes this very unlikely for the region around the sun covered by the observations. In this connection it is especially desirable that the law according to which the observed displacements depend on the star's angular distance from the sun's center should be established with greatest accuracy. The plates obtained with the 5-foot cameras when measured and reduced will furnish additional information on this point

Other observations on the Einstein eclipse problem at the eclipse of September 21, 1922, were made by Prof. Chant and Dr. Young. The results of their two plates, although not very definite, are on the whole favorable to Einstein's prediction.

The present state of our problem may be summarized by saying that the observations made during the total solar eclipses of 1919 and 1922 by different observers and instruments prove the existence of light deflections in close numerical agreement with the prediction of Einstein's generalized theory of relativity, and lead to the conclusion that light is subject to gravitation and that Einstein's law of gravitation is more accurate than Newton's law.

RECENT LATITUDE RESULTS AT LICK OBSERVATORY.

By R. H. Tucker.

The bisection error at the nadir has been measured from one hundred readings, equally distributed between the two positions of the observer, facing south and facing north. The mean correction to the latitudes hitherto computed is —0″.04 ±0″.01.

The bisection error of stars at the zenith has also been again measured, in the past year. The mean correction, from 142 measures, is 0″.07 ±0″.01, and the correction is of the contrary algebraic sign to that of the atmospheric refraction.

The effect depending upon the direction in which the declination micrometer is turned—always right handed or clockwise—has also been measured from the same readings. For both stars and nadirs this direction of revolution is apparently upward for one position of the observer, and downward for the reverse position. The mean correction is 0″.01, and may be considered as negligible in comparison with its probable error.

The latitude, for the epoch 1923.1, from declination observations of 243 stars, between 30° and 45° north declination, is

$$37^\circ\ 20'\ 25''.57\ \pm 0''.03$$

The declinations of the Preliminary General Catalogue of Lewis Boss require a periodic correction of the form

$$-0''.04 \sin (\alpha - 7^h) - 0''.12 \cos (\alpha - 7^h).$$

This correction has been derived from the hourly differences each night, and does not depend upon any adopted latitudes.

The computed latitude variation from the meridian circle observations of fourteen months is

$$\phi - \phi_0 = -0''.10 \cos (t - 1922.7)\ 302^\circ - 0''.01 \cos (t - 1922.8)\ 360^\circ.$$

The strong meridian circle series of epoch 1907.3 gave the latitude,

$$37^\circ\ 20'\ 25''.64\ \pm 0''.04.$$

The difference of these two results, 0″.07 ±0″.05, would give a yearly rate of —0″.004 ±0″.003.

If all the observations, however, since 1906 are employed, the small computed rate has the contrary sign, in this interval.

The mean value of the latitude since 1906.3 is 37° 20′ 25″.58 ±0″.02 and the mean value preceding that epoch was 25″.60 ±0″.02.

ON ATMOSPHERIC ABSORPTION.

By H. L. Vanderlinden.

The present study on the extinction of light in the earth atmosphere has been made at the Royal Observatory of Belgium, at Uccle-Brussels, and is based on observations of five stars belonging to different spectral types, in order to investigate the influence of the color of the

stars. The stars used for this purpose were the following: η Ursae Majoris (B3), α Cygni (A2), α Aurigae (G), β Geminorum (K0) and β Andromedae (Ma). The method of observation consisted in comparing these stars with Polaris, by means of a polarizing Zöllner photometer, attached to a 6-inch refractor. The artificial star was produced by an 8-volt lamp fed by a battery of 60 ampere hours. The total number of observations is 601; they extend between 2 and 88 degrees zenith-distance and cover a period of over three years, from 1915 April 18 to 1918 June 15.

The polar star being a well known variable, all our observations have been corrected for its light variation according to the following elements by Pannekoek:

$$\begin{aligned} \text{Maximum} &= \text{J.D. } 2418985.93 + 3^{d}.96809\, E \\ \text{Magnitude} &= 2^{M}07 + 0^{M}029 \sin(\phi - 72^{\circ}) \\ &\quad \text{Amplitude} = 0^{M}057. \end{aligned}$$

The extinction in stellar magnitudes is found from

$$E(z) = m_z - m_0 = -(\log p/0.4)\ [F(z) - 1] \qquad (1)$$

in which: m_z is the magnitude of the star at zenith distance z.

m_0, the magnitude of the same star at the zenith,

p, the transmission coefficient of the air in the direction of the zenith, and $F(z)$, the mass of air passed by the light at zenith distance z, when the mass of air for the zenith is taken as unity.

The determination of the function $F(z)$ is the general aim of all extinction theories and has been done in various ways by Lambert, Bouguer, Laplace and more recently by Bemporad.

Bemporad has computed extended tables of the function $F(z)$ between altitude of 0 and 5000 meters. He also established other tables for correcting those values of $F(z)$ for temperature and pressure. Hence, the function $F(z)$ can be considered as known and our problem is reduced to the determination of the transmission-coefficient p.

In that way, if we write the equation (1): *(a)* in the case of an extinction star and *(b)* in the case of our comparison star, and subtract the second from the first, we get a new equation:

$$\Delta m_0 - (\log p/0.4)\ \Delta F - \Delta m_z = 0. \qquad (2)$$

in which Δm_0 denotes the true difference in magnitude between the extinction star and the polar star; Δm_z is the observed difference, and the second term is the difference of extinction between those two stars. Each observation leads thus to an equation of the preceding form in which Δm_0 and p are the unknown quantities. A least-squares solution for every star gives the following values with their probable errors:

		Δm_0 M	*p. e.*	p	*p. e*	*p. e.* of 1 obser. M
η Urs. Maj.	(B3)	—0.069	±0.003	0.764	±0.002	±0.034
α Cygni	(A2)	—0.052	5	.771	2	48
α Aurigae	(G)	—1.400	5	.789	2	31
β Geminor.	(Ko)	—0.562	3	.834	2	55
β Androm.	(Ma)	+0.194	7	.830	3	57

The results are as satisfactory as might be expected. The values of p are evidently increasing with advancing spectral type, except for a little discrepancy in the last two stars.

For spectral-groups B, A; G; K, Ma, we have hence respectively

Spectral group	p
B, A	0.768
G	0.789
K, Ma	0.832

The mean value of p is:

$$p = 0.798$$

for a barometric pressure of 755 mm. The corresponding normal value of p (760 mm.) is 0.793, which is identical with that obtained formerly by Seidel, at Munich, but less than Mueller's value 0.835 for Potsdam. The residuals do not show any deviation from the normal law of errors, indicating that p is really independent from the zenith-distance. The details will soon be published in the *Annals of the Uccle Observatory*.

NOTES ON PROPER MOTION.

By A. van Maanen and Hannah M. Marsh.

The following stars of large proper motion were recently found:

α (1900)	δ (1900)	ph. mag.	μ	p	Remarks
$5^h\ 33^m\ 24^s$	$+53°\ 27'$	11.6	$0''.518$	$182°$	Near Pi. 5^h146
11 56 52	+43 48	14.0	0.504	148	Near Lal. 22632
17 29 3	+16 22	14.1	0.286	228	Near P. G. C. 4447

Mrs. Marsh has recently measured the proper motions of four planetary nebulae. The results are as follows:

N.G.C.	$\mu\alpha$	$\mu\delta$	Interval
	$''$ $''$	$''$ $''$	^{y}
6210	$+0.024 \pm 0.002$	-0.016 ± 0.006	5.03
6572	-0.071 ± 0.002	$+0.040 \pm 0.003$	5.02
6720	-0.006 ± 0.001	$+0.016 \pm 0.004$	6.04
7662	$+0.022 \pm 0.002$	-0.004 ± 0.002	6.03

All the plates measured were secured at the 80-foot focus of the 60-inch Mount Wilson reflector.

THE SYSTEMATIC CORRECTIONS TO BOSS' PRELIMINARY GENERAL CATALOGUE.

By William B. Varnum.

During the past few months my time has been largely spent in the investigation of P. G. C. for systematic errors. The examination has been confined entirely to the data as published in P. G. C., especially to the systematic corrections.

The result of this examination has been to disclose very systematic errors and, in the case of the error of the form $\Delta\delta_\delta$ rather large. The size of the error in $\Delta\delta_\delta$ led us to a solution for Solar Apex. This solution was in a form differential to Dr. Boss' solution as given in *A. J.* Vol 26, No. 614; that is, I assumed that the new values of X, Y, Z, as derived with the new proper motions were corrections to the Boss values of X, Y, Z. Applying the new values of X, Y, Z to the value as given in No. 614, page 12, a new solution for the solar apex was made. This new solution gave:

$$\begin{aligned} A &= 271^\circ.24 \\ D &= +26^\circ.72 \\ M &= 3''.527 \end{aligned}$$

This new value is much more accordant with that from radial velocities than the old.

Another very pleasing feature of the systematic errors thus disclosed was the fact that they indicate a correction of Newcomb's equinox for 1908 of —".057. This amount compares very favorably with the more recent values derived from observations; —".052 by Eichelberger for Washington, '08, and of —".068 by Hough for Cape '08.

A point that may please the latitude observers is also brought out; the correction to the Boss proper motions at +39° of declination is +".0043, annual. In *Special Publication* No. 80 of the U. S. Coast and Geodetic Survey, Lambert gives +".0048 for the annual correction indicated.

A similar investigation is now being carried on for the fundamental system of Dr. Auwers. From the results so far obtained I am sure that quite similar results will be found for Auwers. In these two separate investigations *no use* was made of the observations of Bradley. I have parallel lines of investigation going in which Bradley's observations are included in the solutions. I feel sure that when these other results, including Bradley, are at hand we will be able to indicate the source of some of our systematic errors in fundamental systems.

THE RADIAL DISPLACEMENTS IN THE WALLAL PHOTOGRAPHS.

By William B. Varnum.

The receipt of *Lick Observatory Bulletin* No. 346 recently gave me the long desired opportunity to test out how far *differential refraction* would go in explaining this phenomenon. The data for such an examination are as follows:

ϕ of Wallal	$= -19^\circ\ 45'\pm$	Barometer	$= 30.28$
δ of sun	$= +\ 1^\circ\ 1'$	γ beginning	$= +80^\circ.0$
t (hour-angle)	$= 24^\circ\ 45'$	γ ending	$= +79.5$
ζ of sun	$= 329^\circ\ 56'$ S. Z. D		

These give as our various coefficients for *differential refractions*:

μ beginning	= .9413	F''	= +2.73
μ ending	= .9443	F'	= +1.34
μ_0 middle	= .943	$F'' \mu_0 \rho$	= 9.83
ρ for 5^m	= + .30	$F' \mu_0 \rho$	= +4.54
ρ for 1^h	= +3.60		

For explanation of these various quantities see *Astronomical Journal* No. 801.

On page 9 of my paper are given the values of f and f' for each of the 22 stretches investigated. Using these values of f and f', the following values of the effect of dR upon the position of a star, situated, with respect to our zenith, similarly to the sun and the zenith of Wallal at the time of the eclipse, are found:

	″	″	″		″	″	″
666	+1.770	−0.018	+1.770	760	+0.486	+0.400	+0.629
669	+2.168	−0.368	+2.199	771	+1.002	+0.867	+1.325
684	+1.194	+0.073	+1.196	784	+3.538	+0.540	+3.579
686	−1.666	+0.045	+1.666	815	−3.672	+0.200	+3.677
691	+3.126	−0.209	+3.133	825	−0.058	+0.994	+0.996
700	−0.207	+0.068	+0.218	855	−0.030	−0.867	+0.868
711	+1.444	−0.041	+1.445	866	−0.928	+0.499	+1.053
728	+2.344	−0.036	+2.344	883	+2.625	−1.367	+2.960
733	+1.490	+0.586	+1.601	903	+1.725	−1.235	+2.171
739	+1.490	+0.872	+1.727	948	−4.084	+1.639	+4.400
754	+0.207	+0.631	+0.664	950	+0.369	+0.109	+0.385
						Mean	= +1″.818
						Einstein	= +1.745

Column (1) gives the current number of the series at Albany, column (2) gives $+9.83\,f$, column (3) $+4.54\,f'$, column (4) gives the combined displacement, which is comparable to the *radial displacement* of the Wallal photographs. This last column is derived from columns (2) and (3) by solving for position angle and distance, where (3) is the *sine* component and (2) is the *cosine* component. (*A. J.* 801, Fig. 1). While the values for different nights have a large range, nevertheless the mean value should represent the average value for Albany. The mean value, +1″.818 will then represent the average displacement at Albany of a star situated 30° south of the zenith and having a declination of +1°, under the same atmospheric conditions that existed at Wallal. That the displacement would be *radial* at the time of a solar eclipse seems to me to be a logical conclusion since a cross-section of the prism causing the displacement would be circular, hence the prismatic action would be from the centre outward. The close agreement between my value and that of Einstein may, of course, be entirely fortuitous. The results from the coming eclipse will show how fortuitous.

MEAN ABSOLUTE MAGNITUDES OF THE LONG-PERIOD VARIABLES AND OTHER STARS OF LATE TYPES.

By Ralph E. Wilson.

An investigation of the meridian data on variable stars, presumably of long period, belonging to spectral types earlier than Mc, has added 86 proper-motions to those of 315 red stars published earlier in the year.[1] From the proper-motions in the two lists with probable errors less than ″.015 per annum, certain approximations to the mean absolute magnitudes of the separate classes of stars have been made as follows:

Spec.	M.	No. of Variables	Spec.	M.	No. of Variables
Misc.,F, G, K	+0.6	44	Pec.	+0.4	6
Ma	+0.5	11	S	+0.2	14
Mb	+0.6	24	R	−2.0	15
Mc	+0.3	26	Na	−1.6	16
Mabc	+0.4	61	Nb	−2.2	52
Md	±0.0	89	N	−2.2	77

While these magnitudes are only fair approximations, due to assumptions made to supplement a lack of radial-velocity data for certain classes, it is of interest to note the small range of magnitude in those classes composed wholly of variable stars and the definite break when we pass to stars of classes R and N. From the agreement of these values with those computed by Luyten for the giants of types F5 to Mb[2] there appears to be no great range in mean absolute magnitudes for the giants in spectral classes F5 to S. As has been suggested by Moore[3], the Nb stars appear to be definitely more luminous than those with Na spectra. The added stars of Class N appear to be more closely associated with the Nb stars than with the Na.

(To be continued.)

FROM SOLSTICE UNTO SOLSTICE.

From dipper's Archer of the Milky Way
To twinkling Twins in starry Gemini,
Our Sun climbs slowly northward, day by day,
Past stars that shine unseen in azure sky.

From Archer unto Capricornus, and
Aquarius to coupled Pisces when
The month of March is reigning o'er the land,
And nature, roused by spring, awakes again.

From Pisces to the Ram, our Sun ascends,
To Taurus and at length to Gemini
When, lingering, the springtime season ends,
And Vega beams like herald of July.

From sear December unto verdant June,
Our Sun shines higher with each passing noon.

—Charles Nevers Holmes.

41 Arlington St., Newton, Mass.

[1] *Astronomical Journal*, **34**, 183, 1923.
[2] *Publications Astronomical Society of the Pacific*, **35**, 211, 1923.
[3] *Idem*, **35**, 125, 1923.

CELESTIAL PHENOMENA IN 1924.

Eclipses.

During the year there will be five eclipses, three of the sun and two of the moon.

According to the *American Ephemeris* the first of these is a total eclipse of the moon on February 20. The beginning will be visible in the extreme northwest of North America, the Pacific Ocean, Australia, Asia and the Indian Ocean, while the ending will be visible in the western part of the Pacific Ocean, Asia, Australia, the Indian Ocean, Europe and all of Africa except the extreme northwestern part. The circumstances of the eclipse are as follows:

		G.M.T. d	h	m
Moon enters Penumbra	Feb.	20	1	14.9
Moon enters shadow		20	2	18.3
Total eclipse begins		20	3	19.6
Middle of eclipse		20	4	8.5
Total eclipse ends		20	4	57.4
Moon leaves shadow		20	5	58.5
Moon leaves penumbra		20	7	1.5

Magnitude of the eclipse 1.605.

The second will be a partial eclipse of the sun on March 5. The diagram on page 39 shows the region in which the eclipse will be visble. The circumstances are as follows:

		G.M.T. d	h	m	Long. from Gr. °	′	Latitude °	′
Eclipse begins	Mar.	5	1	55.4	+131	14	—68	14
Greatest eclipse		5	3	43.9	— 55	47	—72	2
Eclipse ends		5	5	32.8	— 13	50	—34	36

Magnitude of greatest eclipse =0.582

The third will also be a partial eclipse of the sun occurring July 31. Like the second this eclipse will be visible only in far southern regions.

		G.M.T. d	h	m	Long. from Gr. °	′	Latitude °	′
Eclipse begins	July	31	6	51.7	+163	53	—54	32
Greatest eclipse		31	7	57.9	+145	53	—69	35
Eclipse ends		31	9	3.7	+100	4	—68	18

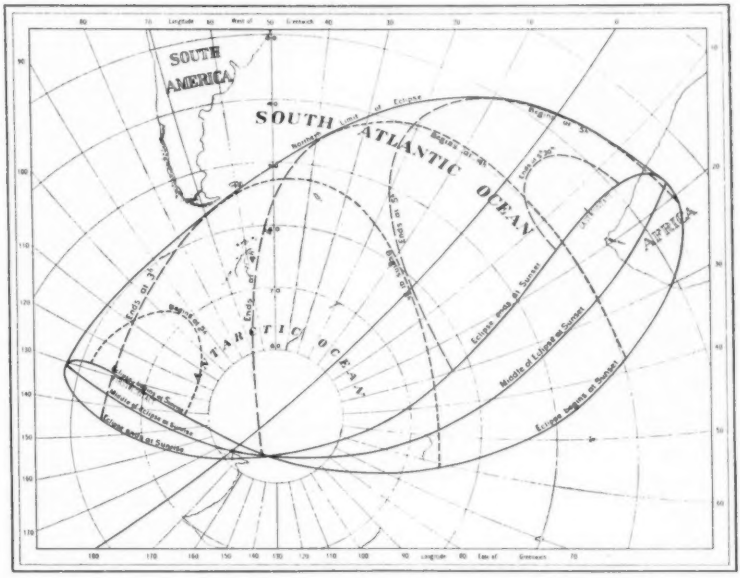
Magnitude of greatest eclipse =0.191

The fourth eclipse of the year will be a total eclipse of the moon on August 14. The beginning will be visible in the western part of the Pacific Ocean, Australia, Asia, the Indian Ocean, eastern and central Europe and Africa except the northwestern part, while the ending will be visible in central and western Asia, western Australia, the Indian Ocean, Europe, Africa, the Atlantic Ocean and eastern and central South America. The circumstances of this eclipse are

		G.M.T. d	h	m
Moon enters penumbra	Aug.	14	5	32.5
Moon enters umbra		14	6	31.3
Total eclipse begins		14	7	30.6
Middle of eclipse		14	8	20.1
Total eclipse ends		14	9	9.4
Moon leaves umbra		14	10	8.6
Moon leaves penumbra		14	11	7.3

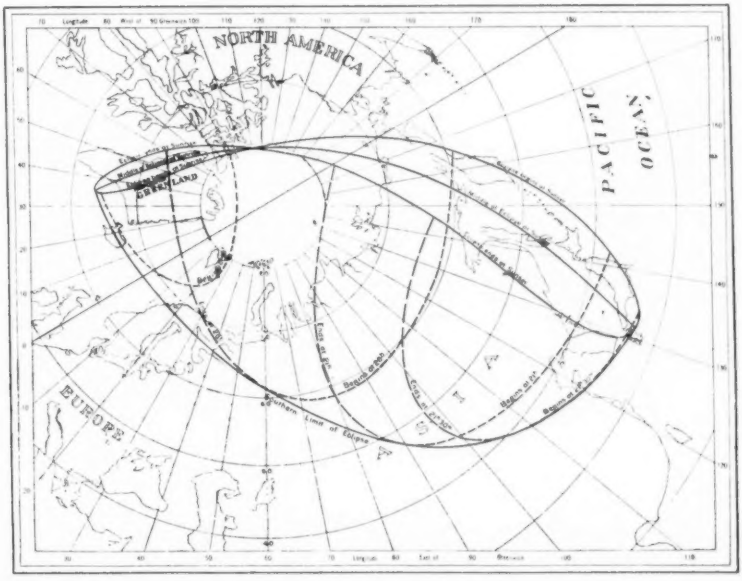
Magnitude of eclipse =1.659

PARTIAL ECLIPSE OF MARCH 5, 1924.



Note:- The hours of beginning and ending are expressed in Greenwich Mean Time.

PARTIAL ECLIPSE OF AUGUST 29, 1924.



Note:- The hours of beginning and ending are expressed in Greenwich Mean Time.

The last eclipse of the year will be a partial one of the sun on August 29. The diagram on page 39 shows the area within which it will be visible. The circumstances are as follows:

	G.M.T.			Long. from Gr.		Latitude	
	d	h	m	°	′	°	′
Eclipse begins	Aug. 29	18	50.4	+ 41	35	+71	49
Greatest eclipse	29	20	22.5	—173	5	+71	32
Eclipse ends	29	21	55.0	—129	23	+41	5

Magnitude of greatest eclipse =0.426

The Planets.

The diagrams on pp. 41 and 42 show the paths of the planets in the sky.

Mercury makes a complete circuit of the heavens, beginning and ending the year in Sagittarius. During January and February it completes a loop in Sagittarius, makes an S-shaped curve in Aries during May, makes a second loop during the last half of August and the first half of September in Leo and makes a half loop in Sagittarius in December.

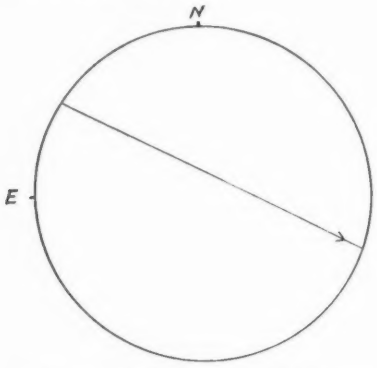
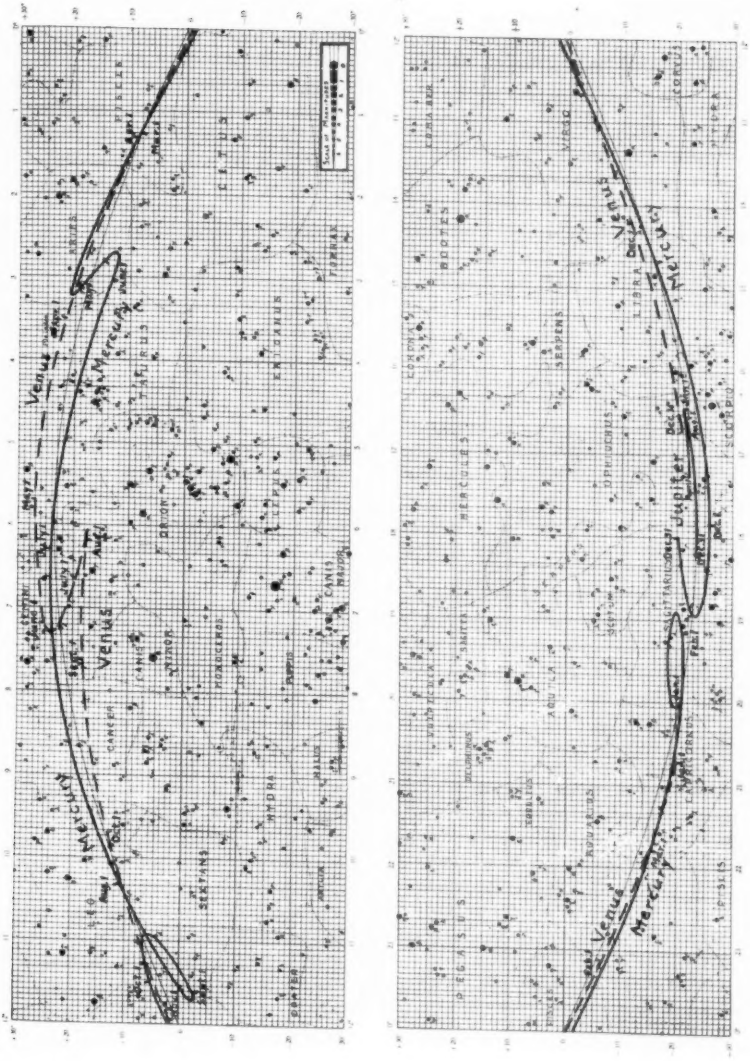


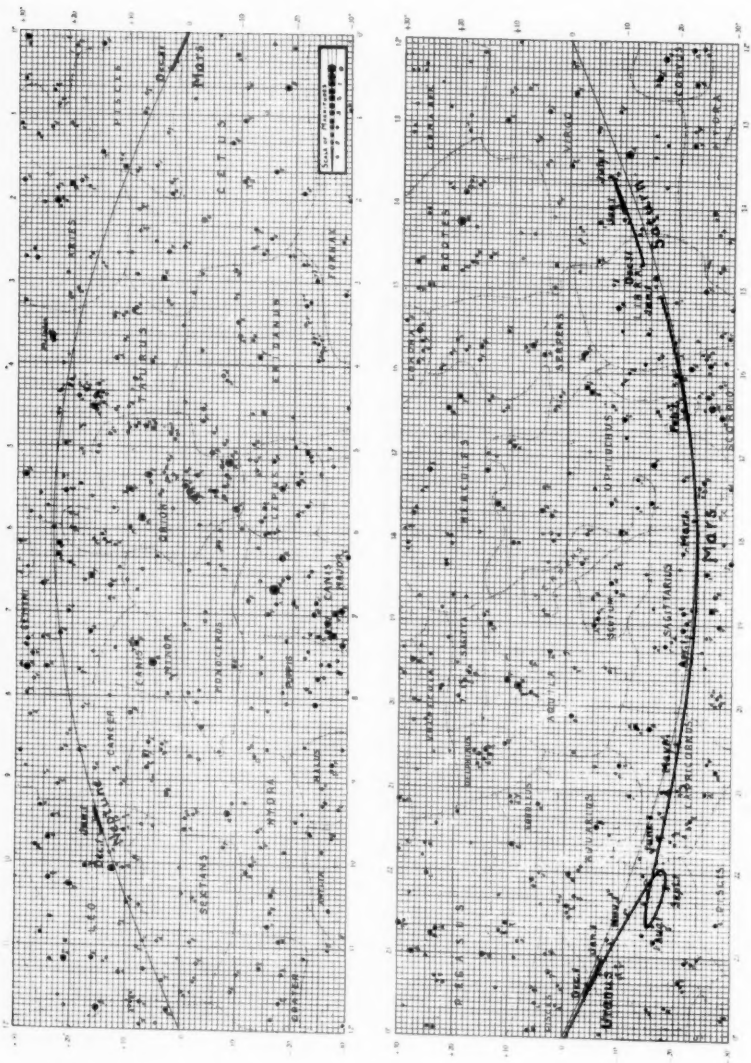
Diagram of the Transit of Mercury across the disk of the Sun, May 7, 1924.

The most interesting feature of the year in connection with Mercury will be a transit across the sun's disk on May 7. The ingress will be visible in the western part of the Atlantic Ocean, North America, the northern and western parts of South America, the Pacific Ocean, eastern Asia and eastern Australia, while the egress may be seen from the extreme northwestern part of North America, the central and western parts of the Pacific Ocean, Asia, Australia, the Indian Ocean, Europe, and Africa except from the extreme northwestern part. The accompanying diagram shows the path of the planet across the sun. The following Greenwich Mean Times refer to the geocentric phases.

	G.M.T.			
	d	h	m	s
Ingress, exterior contact	May 7	9	44	4.4
Ingress, interior contact	7	9	47	3.9
Least distance of centers, 1′ 24″.8	7	13	41	27.7
Egress, interior contact	7	17	35	41.2
Egress, exterior contact	7	17	38	40.9

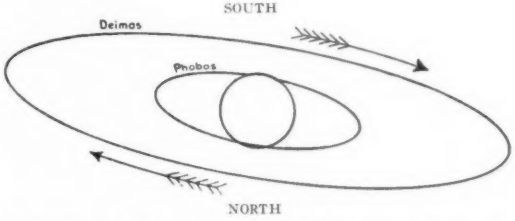


Apparent paths of the planets Mercury, Venus and Jupiter, among the stars during the year 1924.



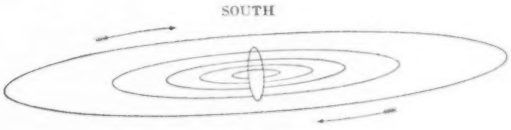
Apparent paths of the planets Mars, Saturn, Uranus and Neptune, among the stars during the year 1924.

Venus begins the year in Capricornus, and, with the exception of a reversed curve during June and July, moves continuously eastward and ends the year in Ophiuchus.



Apparent orbits of the satellites of Mars, at date of opposition, Aug. 23, 1924, as seen in an inverting telescope.

Mars begins the year in Libra and also moves eastward continuously except for a loop in Aquarius at the time of opposition. The latter occurs on August 23, but on account of the large southerly declination the planet will not be especially well located for northern observatories.



Apparent orbits of the satellites of Jupiter at date of opposition, June 5, 1924, as seen in an inverting telescope, and elongated in the ratio of three to one in the direction of their minor axis.

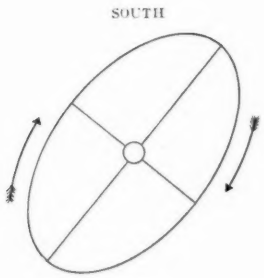
Jupiter will be found in Ophiuchus in January and will move eastward until April 5, then retrograde until August 7 and thereafter eastward until the end of the year when it will be in Sagittarius. The maximum declination of the planet will be —21° this year so that it will be seen only at low altitudes by northern observers. The satellite phenomena will be published as usual when the planet is visible.

Saturn begins the year in Virgo and moves slowly eastward until February 11, then westward until June 29 and finally eastward into Libra where it will be found in December. The satellite phenomena for this planet will also be published when it is in position for observing. For diagram showing the orbits of Saturn's satellites see page 47.

Uranus begins the year in the western part of Sagittarius and closes it in Pisces. The planet is gradually moving northward and by the close of another year will be close to the equator. As will be seen from the diagram on page 44 the earth is very nearly in the plane of the satellites.

Neptune will be in Leo throughout the year. It will move slowly westward until the end of April, then eastward until near the end of November and again westward to the end of the year.

Apparent orbits of the satellites of Uranus at date of opposition, September 12, 1924, as seen in an inverting telescope.



Apparent orbit of the satellite of Neptune at date of opposition February 8, 1924, as seen in an inverting telescope.

The Comets.

Three of the regular periodic comets, which have been observed at numerous returns, are due at perihelion again this year, viz. Encke's, Faye's and Tempel's first comet. Several other faint comets whose periods as calculated are short, but which have not been observed at their successive returns, are due this year according to the elements, but these are so uncertain that predictions of the comets' paths cannot be made.

1. Faye's comet is due at perihelion about September 23 under quite favorable conditions. It should be picked up during the summer.

2. Encke's comet is due at perihelion about October 27 and should be seen with the aid of a telescope in August and September.

3. Tempel's comet will be behind the sun when at perihelion, about November 29, and so may not be seen unless it should be picked up early this year, while it is far out from the sun.

Other comets which may possibly be picked up accidentally during the year are Swift's 1889 VI, due about January 18; Spitaler's 1890 VII, due about May 29; Tuttle's 1858 III, due about June 6; Schorr's 1918, due about June 2; Swift's 1895 II, due about July 16; Tuttle's 1858 I, due about December 3.

Occultations.

A number of interesting occultations will be visible this year. Among the stars occulted will be Aldebaran, Regulus and γ Virginis, and the planets Mercury, Venus, Mars, Uranus and Neptune.

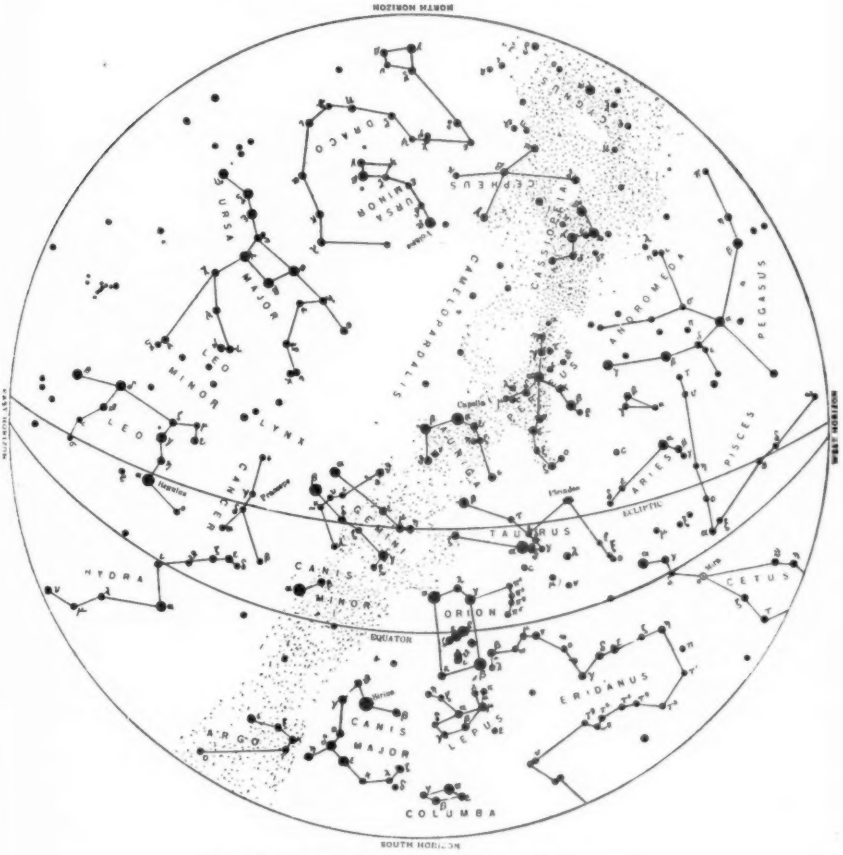
PLANET NOTES FOR FEBRUARY.

The *Sun* will move northeast from $20^h\ 55^m$ to $22^h\ 45^m$ and from $-17°\ 22'$ to $-7°\ 57'$. It will pass from the constellation Capricornus into the constellation Aquarius.

The *moon* will be farthest from the earth on February 12 and nearest the earth on February 25.

The phases of the moon will occur as follows:

New moon	February 4 at 8 P. M.	C.S.T.
First quarter	12 " 2 P. M.	"
Full moon	20 " 10 A. M.	"
Last quarter	27 " 7 A. M.	"



THE CONSTELLATIONS AT 9:00 P. M. FEBRUARY 1.

Mercury will be west of the sun at the beginning of the month and will reach a point of greatest elongation west on February 5. On and near this date it will rise nearly an hour and a half before the sun, and consequently may be seen just before sunrise near the eastern horizon a little south of the point at which the sun rises.

Venus will continue its motion eastward a little faster than the sun and hence will be higher in the western sky at sunset from day to day. It will be very brilliant during the month. It will move nearer the earth a distance of about fifteen million miles during the month.

Mars will still be visible in the early morning. It will move nearer the earth during the month from a distance of 165 million miles to 139 million miles. At the end of the month it will be about one and a half times as far away as the sun.

Jupiter will be visible in the morning. At the end of the month it will be on the meridian at $6^h\ 30^m$ A. M. It will be 22 degrees south of the equator, and hence not so well situated for northern observers.

Saturn will be coming into better position again. At the end of the month it will rise about 9 P. M.

Uranus will be very near the sun and will not be visible during the month.

Neptune will be in opposition to the sun on February 8. It will then rise at sunset, and after that date it will rise before sunset.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1924	Star's Name	Magnitude	IMMERSION. Washington M.T. h m	IMMERSION. Angle from N °	EMERSION. Washington M.T. h m	EMERSION. Angle from N °	Duration h m
Feb. 9	*f* Piscium	5.3	6 34	94	7 43	220	1 8
10	39 B. Arietis	6.5	7 17	18	8 9	299	0 52
13	70 Tauri	6.4	4 51	71	6 21	252	1 30
13	θ^1 Tauri	4.2	7 12	119	8 20	214	1 9
13	75 Tauri	5.2	7 36	12	8 17	321	0 41
13	264 B. Tauri	4.8	8 37	88	10 3	255	1 26
13	275 B. Tauri	6.5	10 43	80	11 55	270	1 12
13	α Tauri	1.1	12 12	41	12 57	312	0 44
14	115 Tauri	5.3	12 54	45	13 37	317	0 44
15	19 B. Geminorum	6.2	9 46	47	10 48	317	1 2
17	3 Cancri	5.7	10 15	59	11 18	326	1 3
18	54 Cancri	6.3	7 42	76	8 54	304	1 12
20	49 Leonis	5.7	6 39	188	6 44	198	0 5
23	65 Virginis	6.0	9 47	110	10 47	294	1 0
23	66 Virginis	5.7	10 30	133	11 29	273	0 59
23	*l* Virginis	4.8	15 38	188	16 4	226	0 25
29	226 B. Sagittarii	6.4	15 54	111	16 56	254	1 2

Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

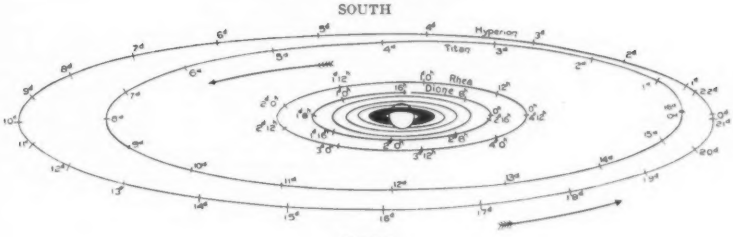
[From the *American Ephemeris.*]

CENTRAL STANDARD TIME. NOON = 0^h

1924	h m			1924	h m		
Feb. 5	15 40	III	Oc. R.	Feb. 19	16 56	III	Ec. D.
	16 54	I	Ec. D.	21	15 9	I	Ec. D.
6	15 10	I	Tr. I.	22	14 29	I	Sh. E.
	16 14	I	Sh. E.		15 41	I	Tr. E.
	17 20	I	Tr. E.	23	13 53	III	Tr. E.
12	15 7	III	Ec. R.	24	15 33	II	Sh. E.
13	15 58	I	Sh. I.		15 41	II	Tr. I.
	17 6	I	Tr. I.	28	17 2	I	Ec. D.
14	16 38	I	Oc. R.	29	14 12	I	Sh. I.
15	15 37	II	Ec. D.		15 26	I	Tr. I.
17	15 22	II	Tr. E.		16 22	I	Sh. E.

NOTE:—I. denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

Saturn's Satellites.



Apparent orbits of the seven inner satellites of Saturn at date of opposition, April 18, 1924, as seen in an inverting telescope.

Greatest elongations visible in the United States.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME. NOON = 0^h

I. Mimas. Period $0^d\ 22^h.6$.

1924	d	h		d	h	1924	d	h		d	h
Feb.	1	17.5 E	Feb.	9	17.7 W	Feb.	17	18.0 E	Feb.	24	19.6 W
	2	16.1 E		10	16.3 W		18	16.6 E		25	18.2 W
	3	14.8 E		11	15.0 W		19	15.4 E		26	16.8 W
	4	13.4 E		12	13.6 W		20	13.9 E		27	15.5 W
	5	12.0 E		13	12.2 W		21	12.5 E		28	14.1 W
	7	20.5 W		14	10.8 W		22	11.1 E		29	12.7 W
	8	19.1 W		16	19.4 E						

II. Enceladus. Period $1^d\ 8^h.9$.

Feb.	1	0.8 E	Feb.	7	21.1 E	Feb.	14	17.5 E	Feb.	21	13.9 E
	2	9.7 E		9	6.0 E		16	2.4 E		22	22.8 E
	3	18.5 E		10	14.9 E		17	11.3 E		24	7.7 E
	5	3.4 E		11	23.7 E		18	20.2 E		25	16.5 E
	6	12.2 E		13	8.6 E		20	5.0 E		27	1.4 E
										28	10.3 E

III. Tethys. Period $1^d\ 21^h.3$.

Feb.	2	14.0 E	Feb.	10	3.0 E	Feb.	17	16.1 E	Feb.	25	5.3 E
	4	11.2 E		12	0.3 E		19	13.4 E		27	2.6 E
	6	8.4 E		13	21.6 E		21	10.7 E		28	23.9 E
	8	5.7 E		15	18.8 E		23	8.0 E			

IV. Dione. Period $2^d\ 17^h.7$.

Feb.	1	1.7 E	Feb.	9	6.8 E	Feb.	17	11.9 E	Feb.	25	16.9 E
	3	19.4 E		12	0.5 E		20	5.6 E		28	10.5 E
	6	13.1 E		14	18.2 E		22	23.2 E			

V. Rhea. Period $4^d\ 12^h.5$.

Feb.	1	20.8 E	Feb.	10	21.7 E	Feb.	19	22.5 E	Feb.	28	23.2 E
	6	9.2 E		15	10.1 E		24	10.8 E			

VI. Titan. Period $15^d\ 23^h.3$.

Feb.	6	21.8 E	Feb.	14	21.9 W	Feb.	22	20.4 E			

VII. Hyperion. Period $21^d\ 7^h.6$.

Feb.	8	12.7 W	Feb.	19	21.8 E	Feb.	29	16.4 W			

NOTE—E, Eastern Elongation; W, Western Elongation.

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1924 February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8				19 15				
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	3 12	11 4	18 20		26 12			
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	1 19	5 22	18 4		24 6			
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	1 9	5 22	18 4		24 6			
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	5 13	14 3	22 16					
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	6 4	13 1	19 21		26 10			
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	3 8	10 12	17 17		24 21			
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	7 15	16 10	25 4					
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	2 19	10 17	18 16		26 15			
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6					28 22			
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	5 5	13 19	22 9					
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	5 4	11 23	18 18		25 13			
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	7 7	15 4	23 2					
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	5 15	13 22	22 6					
RV Persei	4 04.2	+33 59	9.5—12.0	1 23.4	7 18	15 16	23 13					
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	3 9	16 14	29 19					
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	5 9	11 16	17 23		24 6			
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	6 15		19 2					
TT Aurigæ	5 02.8	+39 27	7.8— 8.7	0 16.0	3 17	10 9	17 1		23 17			
RY Aurigæ	11.5	+38 13	10.7—11.7	2 17.5	7 5	15 9	23 14					
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	1 17	7 17	19 19		25 19			
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	7 5	15 21	24 13					
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9		11 7	21 17					
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	6 6	14 6	22 6					
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	5 15	11 9	22 20		28 13			
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	5 10	11 0	22 5		27 19			
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	2 5	10 10	18 15		26 20			
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	2 7	9 22	17 13		25 4			
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	1 23	14 4	26 9					
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	7 23	15 4	22 8		29 12			
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	4 21	11 17	18 13		25 8			
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	2 20	12 3	21 11					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	7 7	13 22	20 13		27 3			
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	5 17	14 3	22 12					
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	1 21	8 7	21 4		27 14			
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	4 19	12 1	19 8		26 15			
X Carinae	8 29.1	—58 53	7.9— 8.7	0 13.0	6 23	15 2	23 4					
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	4 13	14 0	23 12					
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	1 1	7 21	21 14		28 10			
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	4 16	10 14	22 11		28 9			
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	4 21	11 15	18 9		25 3			
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	5 11	12 21	20 7		27 17			
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	2 13	9 3	22 8		28 23			
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	1 0	9 19	18 14		27 10			
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	8 4	15 12	22 19					
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	2 7	9 2	15 21		26 16			
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	2 4	9 16	17 5		24 17			
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	3 6	12 21	22 11					
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	5 13	13 2	20 12		27 23			
SX Hydræ	13 90.0	—26 23	8.6—12.7	2 21.5	3 12	9 7	20 21		26 16			

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1924 February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	6 20	13 19	20 19	27 19				
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	2 3	9 1	22 20	29 18				
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.3	1 21	10 7	18 17	27 3				
SS Libræ	15 43.4	—15 14	9.3—11.5	0 18.4	1 12	8 17	15 21	23 2				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	4 23	12 8	19 6	27 0				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	1 13	9 20	18 2	26 8				
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	6 10	15 6	24 2					
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	3 6		24 0					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	5 9	12 5	19 0	25 19				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	7 15	16 0	24 9					
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	5 15	11 18	17 22	24 2				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	6 8	12 12	18 16	24 21				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	4 10	11 19	19 4	26 13				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	6 1	14 6	22 10					
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	1 6	8 19	16 9	23 22				
UX Herculis	49.7	+16 57	8.8—10.5	1 15.2	8 12	16 5	23 23					
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	6 23	14 23	22 23					
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	6 10	14 22	23 11					
WY Sagittarii	17 54.9	—23 1	9.5—10.6	4 16.0	4 14	13 23	18 15	27 23				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	5 17	10 21	21 5	26 9				
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	2 16	9 22	17 4	**24 10**				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	7 12	14 10	21 8	28 5				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2		14 23						
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	5 2	12 5	19 9	26 13				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	4 11	11 13	18 16	25 19				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	5 22	14 6	22 13					
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 8	13 20	22 7					
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	5 20	12 12	19 3	25 19				
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	9 18		22 16					
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	4 12	12 3	19 19	27 10				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	5 20	13 10	20 23	28 13				
RV Lyræ	12 5	+32 15	11. —12.8	3 14.4	4 20	12 1	19 6	26 10				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	1 5	10 4	19 3	28 2				
U Sagittæ	14 4	+19 26	6.5— 9.0	3 09.1	4 15	11 9	18 4	24 22				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	5 3	12 12	19 20	27 5				
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	1 22	12 10	17 16	28 4				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	4 12	11 0	17 13	24 1				
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	5 3	11 4	23 4	29 4				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	3 3	9 18	23 0	29 16				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	2 9	6 23	16 3	25 6				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	1 22	10 8	18 18	27 4				
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	6 15	13 10	20 5	27 0				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	1 4	8 2	21 21	28 19				
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0	2 6							
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	9 13	19 3	28 18					
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	1 20	11 1	20 6	29 11				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	1 18	10 18	19 18	28 17				
WZ Cygni	48.3	+38 27	9.9—10.8	0 14.0	6 4	13 18	21 8	28 23				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	2 13	12 16	22 18					
RY Aquarii	21 14.8	—11.14	8.8—10.4	1 23.2	8 3	15 23	23 20					
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	4 10							
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	1 8	11 12	21 15					
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	5 13	10 17	21 2	26 6				
VW Pegasi	51.7	+32 41	10.0—10.6	5 06.4	5 0	10 6	20 19	26 1				
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.3	3 15	11 4	18 17	26 6				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	3 19	12 1	20 7	28 13				

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard time 6h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1924 February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7					20 7			
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	6 16	14 20	23 0					
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 2	9 20	17 13	25 7				
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2		10 3		24 22				
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	7 1	14 23	22 22					
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	1 22	9 17	17 13	25 8				
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0		11 17		28 3				
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	1 6	9 20	18 10	27 0				
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	1 23	13 2	24 5					
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0		10 10	22 1					
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	4 0	11 16	19 8	27 0				
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3	8 11	18 15	28 18					
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	2 17	10 10	18 4	25 21				
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	4 15	10 4	21 5	26 18				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	4 21	12 11	20 1	27 14				
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3			25 11					
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	8 7	15 19	23 5					
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	2 10	10 8	18 6	26 4				
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2 0	12 3	22 7					
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5			17 8					
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	7 12	15 11	23 9					
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	1 11	8 3	21 13	28 6				
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	2 17	14 0	21 6					
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	8 15	17 9	26 3					
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0								
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	6 11	13 6	20 0	26 19				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	4 16	13 6	21 20	26 11				
S Muscae	12 07.4	—69 36	6.4— 7.3	9 15.8	1 1	10 17	20 9					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	4 18	12 18	20 17	28 17				
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	4 14	11 7	18 1	24 18				
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	1 2	6 22	18 13	24 9				
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	4 11	13 20	18 13	27 22				
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5		14 20						
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	8 0	16 5	24 10					
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	6 4	13 4	20 5	27 5				
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	7 7	15 12	23 18					
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	5 7	10 19	21 19	27 7				
RS Bootis	29.3	+32 11	8 9—10.0	0 09.1	4 22	12 11	20 0	27 13				
R Triang.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	4 6	11 2	17 19	24 14				
S Triang.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	2 20	9 4	21 19	28 3				
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1	10 5	19 23	29 17					
RW Draconis	33.7	+58 03	9.6—10 8	0 10.6	5 1	13 21	22 18					
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	6 7	12 8	24 11	30 13				
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	3 19	10 19	17 19	24 19				
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9		12 23						
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	2 3	9 18	17 8	24 22				
Y Sagittarii	18 15.5	—18 54	5 4— 6.2	5 18.6	1 15	13 5	18 23	30 12				
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	2 1	8 19	22 6	29 0				
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	2 20	13 4	23 13					
RZ Lyræ	18 39.9	+32 42	9.9—11.2	0 12.3	2 15	8 18	21 1	27 4				
RT Scuti	18 44.1	—10 30	9.1— 9.7	0 11.9	3 12	9 11	21 8	27 7				
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	5 2	14 4	23 6					
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	1 17	8 17	22 18	29 19				

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1924							
					February							
	h m	° ′		d h	d h		d h		d h		d h	
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	3	20	10	20	17	20	24	20
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	8	4	16	3	24	3		
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	8	12	16	5	23	17		
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	3	7	10	11	17	16	24	20
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	2	16	11	2	19	11	27	20
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	4	23	11	7	17	15	23	22
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	7	9			23	18		
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	4	23	13	20	18	7	27	4
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	3	20	10	14	17	7	24	1
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	3	15	10	9	17	2	23	19
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	5	6			19	23		
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	5	13	13	9	21	6	29	3
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	6	7	13	5	20	2	26	23
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	1	20	11	14	16	11	26	4
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	2	9	11	1	19	16	28	8
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	2	23	13	16	19	1	29	19
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	7	0	17	22	28	19		
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	4	3	10	13	23	8	29	18
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	1	21	11	20	16	20	21	19
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	1	13	12	10	17	21	28	18
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	4	10	9	20	20	17	26	4
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	2	9	8	16	21	6	27	14
RY Cassiop.	47.2	+58 11	9.3—11 8	12 03.4	6	20			18	23		
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	5	9	12	9	19	8	26	8

Five New Southern Variable Stars.—On photographs made during the last two years with the Bruce telescope at Arequipa, Professor Bailey has discovered the following faint variable stars.

Harvard Variable	R.A. 1900	Dec. 1900	Maximum Magnitude	Minimum Magnitude	Probable Period
	h m	° ′			
3700	15 37.2	—37 53	14.5	[18.0	Long
3701	15 39.7	—37 59	14.0	17.0	155^d
3702	15 39.9	—36 49	15.5	18.5	240
3703	15 40.3	—37 42	13.5	15.0	Short
3704	15 41.3	—38 30	13.5	15.0	$0^d.521$

Only one maximum was observed for No. 3700. The observed maxima of No. 3702 are separated by an interval of 480 days. No. 3704 is a cluster type variable. Its distance from the center of the globular cluster N. G. C. 5986 is 65′.

Harvard College Observatory Bulletin 795.

Monthly Report of the American Association of Variable Star Observers, Oct. 20—Nov. 20, 1923.

A very fine set of observations of the incomplete maximum of SS Cygni on J. D. 3733 is included herewith. Mr. Braid-White has been observing with the Yerkes 40-inch under the guidance of Professor Parkhurst. The report this month as a whole is certainly very creditable considering the handicap of bad weather under which most of the members have labored.

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
001022 S SCULPTORIS—						
	3687.0	8.7	Bl.	3704.0	8.5	Kd.
	3702.1	8.6	Kd.	3733.5	7.0	Pt.
001046 X ANDROMEDAE—						
	3712.6	9.6	B.	3726.6	9.8	Bi.
	3722.6	9.7	B.	3734.6	10.2	Pi.
	3723.6	9.2	Wf.	3734.6	9.7	Hu.
001620 T CETI—						
	3697.9	6.3	Kd.	3710.0	6.1	Kd.
	3702.0	6.1	Kd.	3716.0	6.1	Kd.
	3704.0	6.1	Kd.	3723.3	5.2	L.
001726 T ANDROMEDAE—						
	3699.6	13.5	Ie.	3733.5	14.3	Pt.
001755 T CASSIOPEIAE—						
	3712.3	7.7	L.	3727.5	7.8	Ca.
	3712.3	7.5	Lh.	3730.6	7.8	Sg.
	3712.5	7.7	B.	3733.5	8.1	Pt.
	3719.5	7.7	B.	3734.6	8.6	Pi.
001838 R ANDROMEDAE—						
	3723.6	14.6	Wf.	3732.8	14.6	Pa.
	3725.8	14.7	Pa.	3733.5	14.4	Pt.
001862 S TUCANAE—						
	3687.0	11.6	Bl.			
001909 S CETI—						
	3694.7	11.8	Ie.	3724.6	9.0	Ie.
	3701.2	11.0	Ch.	3726.6	9.0	Bi.
	3713.1	9.2	Ch.	3727.5	8.8	Ca.
	3713.3	9.2	L.	3727.7	9.0	Br.
	3713.3	9.2	Lh.	3733.5	9.0	Pt.
	3719.2	9.1	Ch.	3736.5	9.1	Cu.
	3719.5	9.1	Ca.	3737.8	9.2	Sg.
	3719.6	8.1	Bi.	3744.6	9.6	Cu.
	3723.7	8.8	Sg.			
003179 Y CEPHEI—						
	3697.8	15.	Pa.	3725.8	15.	Pa.
	3702.8	16.	Pa.	3732.8	15.	Pa.
004132 RW ANDROMEDAE—						
	3701.2	8.8	Ch.	3733.5	8.9	Pt.
	3715.0	8.3	Ch.	3734.5	9.0	O.
	3722.6	8.5	B.	3738.6	9.1	Pi.
004435 V ANDROMEDAE—						
	3712.6	10.7	B.	3734.6	10.6	Hu.
	3720.6	11.0	B.	3734.6	11.4	Pi.
	3727.7	11.0	Br.	3737.5	11.2	B.
	3734.5	11.1	O.			
004435 X SCULPTORIS—						
	3687.0	11.7	Bl.			
004533 RR ANDROMEDAE—						
	3712.6	10.4	B.	3734.5	10.1	O.
	3722.6	10.3	B.	3736.6	10.6	Hu.
	3723.6	9.9	Wf.	3738.6	10.5	Pi.
004746a RV CASSIOPEIAE—						
	3712.3	10.2	L.	3723.6	9.8	Wf.
	3719.5	9.5	B.	3733.5	9.2	Pt.
	3720.8	9.9	Br.	3734.6	9.6	Pi.
004958 W CASSIOPEIAE—						
	3712.6	11.1	B.	3733.5	11.9	Pt.
	3719.7	11.0	B.	3734.6	12.0	B.
	3727.7	117	Br.			
010102 Z CETI—						
	3724.7	8.8	B.	3733.5	8.6	Pt.
	3727.8	8.7	Br.	3738.6	9.2	B.
010940 U ANDROMEDAE—						
	3723.6	13.9	Wf.			
011041 UZ ANDROMEDAE—						
	3723.6	14.3	Wf.			
011208 S PISCIUM—						
	3727.7	9.8	Br.	3733.5	10.0	O
011272 S CASSIOPEIAE—						
	3696.6	9.0	Ie.	3723.6	9.5	Wf.
	3712.6	9.4	Br.	3733.5	9.1	Pt.
	3719.6	9.4	B.			
011712 U PISCIUM—						
	3733.5	13.5	Pt.			
012233a R SCULPTORIS—						
	3702.1	7.8	Kd.	3710.1	8.0	Kd.
012350 RZ PERSEI—						
	3720.6	13.0	B.	3726.6	12.8	Bi.
	3721.6	13.0	Br.			
012502 R PISCIUM—						
	3723.8	14.4	Pa.			
013238 RU ANDROMEDAE—						
	3723.6	13.2	Wf.	3733.5	12.8	Pt.
013338 Y ANDROMEDAE—						
	3701.2	10.8	Ch.	3733.5	13.2	Pt.
	3721.6	12.9	Br.			
014958 X CASSIOPEIAE—						
	3712.6	10.2	B.	3733.6	11.5	Pt.
	3720.6	10.2	B.	3734.6	10.6	B.
015354 U PERSEI—						
	3717.7	8.0	Sg.	3733.6	8.4	Pt.
	3725.5	8.5	O.	3733.6	8.5	B.
	3728.6	8.2	Sg.	3734.6	8.4	Pi.
015912 S ARIETIS—						
	3733.6	14.5	Pt.			
021024 R ARIETIS—						
	3713.3	8.7	L.	3733.7	8.4	Kl.
	3713.3	8.9	Lh.	3734.6	8.0	Ca.
	3719.5	8.3	Ca.	3734.7	7.9	Cy.
	3723.6	8.3	Wf.	3734.7	8.0	Hr.
	3724.5	8.1	O.	3736.5	8.0	Cu.
	3724.6	8.2	B.	3738.6	8.2	Pi.
	3727.6	7.9	Cy.	3741.7	8.3	Kl.
	3727.5	8.0	Ca.	3743.6	8.1	Kl.
	3728.7	8.4	Kl.	3749.7	8.5	Cy.
	3733.6	7.6	Pt.	3751.6	7.7	Cu.
021143a W ANDROMEDAE—						
	3722.6	6.8	B.	3734.7	7.0	Pi.
	3723.7	7.0	Wf.	3736.6	8.9	O.
	3733.6	6.7	Pt.			
021258 T PERSEI—						
	3733.6	8.1	Pt.			
021281 Z CEPHEI—						
	3720.6	12.4	B.	3733.6	11.7	Pt.
	3721.6	12.0	Br.	3734.8	11.8	B.
	3723.7	11.9	Wf.			

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
021403 o CETI—						
	3701.2	9.2	Ch.	3733.6	6.7	Pt.
	3707.3	9.2	Pe.	3733.7	9.2	Gb.
	3710.6	9.3	Cy.	3734.7	9.3	Cy.
	3712.7	9.0	L.	3734.7	9.3	Hr.
	3715.9	9.4	Kl.	3736.6	9.2	Hu.
	3719.3	9.1	Pe.	3737.8	9.2	Sg.
	3721.2	9.3	Ch.	3741.7	9.0	Kl.
	3723.3	9.2	Pe.	3742.7	9.1	Kl.
	3723.7	9.0	Sg.	3743.6	9.0	Kl.
	3727.6	9.0	Ca.	3746.7	9.1	Cy.
	3728.7	9.1	Kl.	3755.6	9.0	Ms.
	3730.7	9.2	Kl.	3757.5	8.6	Ms.
	3733.6	8.9	Kl.	3758.5	8.8	Ms.
021558 S PERSEI—						
	3703.2	9.3	Ch.	3734.6	8.4	Hu.
	3733.6	8.5	B.	3734.7	8.7	P..
	3733.6	8.6	Pt.			
022000 R CETI—						
	3704.0	8.1	Kd.	3727.6	9.7	Ca.
	3705.2	8.2	Ch.	3727.7	9.7	Br.
	3710.1	8.2	Kd.	3734.6	10.4	Ca.
	3719.6	8.6	Ca.			
022150 RR PERSEI—						
	3723.7	14.0	Wf.	3733.6	13.5	Pt.
022426 R FORNACIS—						
	3687.0	8.0	Bl.			
022813 U CETI—						
	3701.2	11.4	Ch.	3733.6	13.0	Pt.
	3727.8	12.8	Br.	3735.6	12.8	B.
022980 RR CEPHEI—						
	3703.7	12.7	L.	3723.7	13.1	Wf.
	3721.6	12.7	Br.	3733.6	13.0	Pt.
023133 R TRIANGULI—						
	3695.6	9.7	Ie.	3727.7	11.3	Br.
	3609.6	11.0	Ie.	3733.6	11.4	Pt.
	3620.6	10.5	B.	3734.6	11.4	B.
	3624.6	11.2	Ie.	3738.6	11.8	Pi.
	3625.6	11.4	Cu.	3749.7	11.8	Cy.
024356 W PERSEI—						
	3719.5	9.3	Ca.	3733.6	9.2	Pt.
	3725.5	9.9	O.	3734.7	10.0	Pi.
	3726.6	9.4	Bi.	3736.5	9.5	Ca.
	3733.6	9.3	B.	3749.6	9.6	Cy.
025050 R HOROLOGII—						
	3687.0	6.6	Bl.			
025751 T HOROLOGII—						
	3687.0	9.0	Bl.			
030514 U ARIETIS—						
	3723.8	14.2	Pa.			
031401 X CETI—						
	3712.7	12.8	L.	3727.7	12.2	Br.
	3723.7	12.3	Wf.	3733.6	12.4	Pt.
	3725.7	12.3	B.			
032043 Y PERSEI—						
	3725.5	9.5	O.	3734.6	8.5	Hu.
	3733.6	8.6	B.	3734.7	9.2	Pi.
	3733.6	8.0	Pt.			
032335 R PERSEI—						
	3712.7	10.6	Br.	3727.5	9.7	Ca.
	3721.7	9.8	Br.	3733.6	9.5	Pt.
	3723.7	9.5	Wf.	3734.6	9.0	Hu.
	3725.5	9.9	O.	3734.7	9.2	Pi.
042209 R TAURI—						
	3723.8	13.8	Pa.	3733.6	14.0	Pt.
042215 W TAURI—						
	3710.8	11.6	Sg.	3736.6	10.8	O.
	3724.5	10.9	O.	3736.6	10.4	Hu.
	3724.7	10.5	B.	3738.6	10.5	B.
	3727.8	11.2	Br.	3738.6	10.7	Pi.
	3728.6	10.9	Kl.	3741.7	10.9	Kl.
	3733.6	10.9	Pt.	3742.8	10.6	M.
	3733.7	10.8	Kl.	3743.6	10.9	Kl.
042309 S TAURI—						
	3736.6	10.6	Hu.			
043065 T CAMELOPARDALIS—						
	3700.7	10.1	L.	3733.6	12.1	Pt.
	3725.5	11.8	O.			
043208 RX TAURI—						
	3727.8	13.7	Br.	3735.7	13.3	B.
043263 R RETICULAE—						
	3687.0	12.0	Bl.			
043274 X CAMELOPARDALIS—						
	3721.7	12.3	Br.	3725.6	12.5	B.
	3723.7	12.4	Wf.	3733.7	12.1	Pt.
043562 R DORADUS—						
	3687.0	5.5	Bl.			
044349 R PICTORIS—						
	3687.0	7.5	Bl.			
044617 V TAURI—						
	3723.7	8.7	Wf.	3733.7	8.5	Pt.
	3724.5	9.1	O.	3738.6	9.0	Pi.
	3724.7	8.8	B.	3738.6	8.5	B.
	3727.8	8.8	Br.			
045307 R ORIONIS—						
	3727.8	10.3	Br.			
054514 R LEPORIS—						
	3702.6	7.3	L.	3719.7	7.0	Ca.
	3706.3	7.6	Ch.	3725.7	7.0	L.
	3712.7	7.2	L.	3735.7	7.0	Ca.
	3718.2	7.5	Ch.	3741.8	6.9	Pt.
050022 T LEPORIS—						
	3687.2	11.0	Bl.	3741.8	10.6	Pt.
050848 S PICTORIS—						
	3687.2	12.5	Bl.			
050953 R AURIGAE—						
	3713.7	11.5	Bi.	3734.7	10.7	Pi.
	3723.7	10.8	Wf.	3737.6	10.4	B.
	3727.9	10.5	Br.	3753.7	10.3	Pt.
051247 T PICTORIS—						
	3687.2	10.6	Bl.			
051533 T COLUMBAE—						
	3687.2	7.5	Bl.			
052034 S AURIGAE—						
	3700.6	10.0	L.	3735.7	9.4	B.
	3710.3	10.4	Ch.	3737.8	9.5	Sg.
	3723.7	10.3	Sg.	3738.6	10.8	Pi.
	3733.7	9.0	Pt.			

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
052036 W AURIGAE—						
	3700.6	9.0	L.	3733.7	9.2	Pt.
	3710.3	8.8	Ch.	3734.5	9.2	O.
	3725.7	8.9	L.	3737.6	9.6	B.
	3727.9	9.0	Br.			
052404 S ORIONIS—						
	3719.7	8.2	Ca.	3735.7	8.3	Ca.
	3733.7	8.3	Pt.	3742.8	8.2	M.
053005a T ORIONIS—						
	3700.7	10.7	L.	3725.6	10.9	L.
	3702.6	10.2	L.	3724.8	10.8	Pt.
	3703.6	10.0	L.	3726.7	10.8	Pt.
	3712.7	10.1	L.	3733.7	10.4	Pt.
	3713.7	10.3	Pt.	3741.7	10.0	Pt.
	3718.7	10.3	Pt.	3742.8	11.0	M.
053068 S CAMELOPARDALIS—						
	3725.5	8.4	O.	3733.7	8.0	Pt.
053326 RR TAURI—						
	3724.7	12.1	B.			
053531 U AURIGAE—						
	3727.9	12.8	Br.	3737.7	12.7	B.
	3733.7	12.6	Pt.	3738.6	11.2	Pi.
054319 SU TAURI—						
	3702.6	9.6	L.	3727.8	9.4	Br.
	3703.6	9.5	L.	3733.7	9.5	Pt.
	3706.3	9.8	Ch.	3734.6	9.4	Cu.
	3712.7	9.5	L.	3735.8	9.6	Pt.
	3713.7	9.6	Pt.	3738.6	9.4	Pi.
	3714.8	9.6	Pt.	3741.7	9.6	Pt.
	3718.7	9.5	Pt.	3742.8	9.6	M.
	3723.7	9.4	Wf.	3744.6	9.5	Cu.
	3724.8	9.6	Pt.	3751.5	9.4	Cu.
	3725.6	9.4	L.	3752.5	9.4	Cu.
	3725.6	9.6	Cu.	3753.5	9.3	Cu.
	3726.7	9.6	Pt.			
054331 S COLUMBAE—						
	3687.2	12.0	Bl.			
054615a Z TAURI—						
	3727.9	13.5	Br.			
054615c RU TAURI—						
	3727.9	13.0	Br.			
054629 R COLUMBAE—						
	3687.2	10.6	Bl.			
054920a U ORIONIS—						
	3710.7	8.4	Cy.	3734.7	8.8	Cy.
	3711.8	7.8	Sg.	3734.7	8.9	Hr.
	3719.6	7.6	Ca.	3735.7	8.0	Ca.
	3728.7	8.2	Kl.	3737.8	8.6	Sg.
	3729.8	8.4	Sg.	3738.6	8.6	Pi.
	3733.7	8.2	Kl.	3741.7	8.2	Kl.
	3733.7	7.9	Pt.	3742.8	8.5	M.
	3733.7	8.3	Gb.	3746.7	8.8	Cv.
054920b UW ORIONIS—						
	3734.7	10.5	Cy.	3746.7	10.1	Cy.
	3734.7	10.5	Hr.			
054945 TW AURIGAE—						
	3705.1	8.4	Kd.			
054974 V CAMELOPARDALIS—						
	3723.8	[14.0	Pa.	3732.8	16.0	Pa.
055353 Z AURIGAE—						
	3706.3	9.9	Ch.	3733.7	10.1	B.
	3723.7	10.4	Wf.	3733.7	10.3	Pt.
	3724.7	10.3	Wf.	3739.6	10.8	B.
055686 R OCTANTIS—						
	3687.3	10.7	Bl.			
060450 X AURIGAE—						
	3727.9	10.5	Br.	3734.5	10.0	O.
	3733.7	10.1	Pt.	3738.7	9.5	B.
060547 SS AURIGAE—						
	3699.7	[13.3	Ie.	3729.8	[11.6	Sg.
	3706.2	[12.4	Ch.	3730.7	[13.0	Kl.
	3709.6	[12.4	Ie.	3732.8	15.2	Pa.
	3710.3	[11.4	Ch.	3733.6	[12.6	Kl.
	3710.6	[12.4	Wf.	3733.7	[13.7	B.
	3710.8	[13.3	Ie.	3733.7	[12.6	Pt.
	3712.7	14.0	L.	3734.6	[12.6	Kl.
	3712.8	[11.6	Sg.	3734.7	[12.4	Pi.
	3713.7	[11.5	Pt.	3735.6	[12.6	Kl.
	3714.8	[12.0	Pt.	3735.8	[12.6	Pt.
	3716.7	[12.4	Wf.	3736.6	[11.4	O.
	3716.8	[14.0	Pa.	3736.7	13.5	B.
	3718.7	[11.0	Pt.	3737.7	11.0	B.
	3719.6	[12.4	Wf.	3738.5	11.0	Cd.
	3720.6	[12.4	Wf.	3738.7	10.8	Pi.
	3721.6	[13.9	Wf.	3738.7	11.0	B.
	3723.3	[12.4	L.	3739.6	11.3	B.
	3723.6	[14.5	Wf.	3741.7	[12.6	Kl.
	3724.6	[12.6	Ie.	3741.9	12.5	Pt.
	3724.8	[12.4	Pt.	3742.6	[12.6	Kl
	3725.6	[12.4	Pt.	3743.6	[11.8	Kl.
	3725.8	[14.0	Pa.	3751.5	[11.8	Cu.
	3726.7	[12.6	Pt.	3752.5	[12.6	Cu.
	3727.8	[13.3	Br.	3753.5	[11.8	Cu.
	3728.6	[12.6	Kl.			
061647 V AURIGAE—						
	3728.0	10.0	Br.			
061702 V MONOCEROTIS—						
	3728.0	12.8	Br.	3741.8	13.0	Pt.
063308 R MONOCEROTIS—						
	3728.0	12.0	Br.	3741.8	11.0	Pt.
063558 S LYNCIS—						
	3741.8	13.6	Pt.			
064030 X GEMINORUM—						
	3728.0	8.3	Br.			
064707 W MONOCEROTIS—						
	3741.8	10.2	Pt.			
065111 Y MONOCEROTIS—						
	3741.8	11.8	Pt.			
065308 X MONOCEROTIS—						
	3700.7	8.4	L.	3725.7	7.3	L.
065355 R LYNCIS—						
	3723.7	11.4	Wf.			
070122a R GEMINORUM—						
	3713.7	9.3	Bi.	3741.9	7.0	Pt.
	3719.7	7.8	Ca.	3751.6	8.1	Cu.
	3735.7	7.4	Ca.			
070122b Z GEMINORUM—						
	3713.7	12.1	Bi.	3741.9	12.5	Pt.
070122c TW GEMINORUM—						
	3713.7	8.9	Bi			

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
070310 R CANIS MINORIS—						
	3703.7	10.8	L.,	3725.7	9.0	L.
071713 V GEMINORUM—						
	3741.9	8.4	Pt.			
072708 S CANIS MINORIS—						
	3703.7	12.4	L.,	3741.9	12.6	P.
	3725.7	12.7	L.			
072811 T CANIS MINORIS—						
	3741.9	9.6	Pt.			
073173 S VOLTANTIS—						
	3687.3	10.9	Bl.			
073508 U CANIS MINORIS—						
	3700.7	10.2	L.,	3741.9	9.0	Pt.
	3725.7	9.5	L.			
073723 S GEMINORUM—						
	3741.9	12.6	Pt.			
074241 W PUPPIS—						
	3687.3	12.2	Bl.			
074323 T GEMINORUM—						
	3741.9	10.4	Pt.			
074922 U GEMINORUM—						
	3699.4	12.4	Ch.,	3725.6	13.8	L.,
	3700.6	13.3	L.,	3726.7	12.4	Pt,
	3702.6	13.9	L.,	3727.8	13.3	Br,
	3703.6	14.1	L.,	3727.9	13.7	Br,
	3707.3	11.4	Ch.,	3735.8	13.3	Pt,
	3710.3	11.4	Ch.,	3738.7	11.4	Pi,
	3710.8	13.7	Ie,	3741.7	12.4	Kl,
	3712.7	12.4	L.,	3741.9	12.4	Pt.
081112 R CANCRI—						
	3699.5	11.0	Ch.,	3725.7	10.7	L.,
	3703.7	11.0	L.,	3741.9	9.8	Pt.
081617 V CANCRI—						
	3711.4	11.0	Ch.,	3741.9	12.2	Pt.
082405 RT HYDRAE—						
	3700.7	8.2	L.,	3741.9	7.9	Pt.
082476 R CHAMELEON—						
	3682.9	9.6	Bl.			
083350 X URSAE MAJORIS—						
	3741.9	11.1	Pt.			
084803 S HYDRAE—						
	3711.5	9.3	Ch.,	3741.9	10.3	Pt.
085008 T HYDRAE—						
	3711.4	9.5	Ch.,	3741.9	7.8	Pt.
	3712.7	9.7	L.,			
085120 T CANCRI—						
	3700.6	8.5	L.,	3741.9	7.8	Pt.
	3725.7	7.8	L.,			
090024 S PYXIDIS—						
	3741.9	9.3	Pt.			
091868 RW CARINAE—						
	3682.9	11.5	Bl.			
092962 R CARINAE—						
	3682.9	8.9	Bl.			
093014 X HYDRAE—						
	3741.9	12.1	Pt.			
093934 R LEONIS MIN.—						
	3702.7	12.1	L.			
094211 R LEONIS—						
	3699.5	6.6	Ch.,	3742.8	8.0	M,
	3741.9	8.2	Pt.	3743.9	8.8	Cy.
094622 Y HYDRAE—						
	3741.9	6.6	Pt.			
094953 Z VELAE—						
	3687.3	11.5	Bl.			
095421 V LEONIS—						
	3741.9	13.5	Pt.			
100661 S CARINAE—						
	3682.9	5.7	Bl.			
101058 Z CARINAE—						
	3682.9	10.6	Bl.			
101153 W VELAE—						
	3682.9	8.3	Bl.			
103212 U HYDRAE—						
	3710.3	5.4	Kd,	3712.3	5.2	Kd.
103769 R URSAE MAJORIS—						
	3721.6	12.6	Wf,	3736.6	12.5	Cd,
	3728.5	11.2	Cd,	3741.9	12.6	Pt.
104620 V HYDRAE—						
	3741.9	10.4	Pt.			
104628 RS HYDRAE—						
	3687.3	8.8	Bl.			
111661 RS CENTAURI—						
	3682.9	9.9	Bl.			
111441 X CENTAURI—						
	3682.9	9.4	Bl.			
115058 W CENTAURI—						
	3682.9	9.2	Bl.			
120012 SU VIRGINIS—						
	3741.9	10.0	Pt.			
122532 T CANUM VEN.—						
	3741.9	11.2	Pt.			
122854 U CENTAURI—						
	3662.9	8.5	Bl.			
123160 T URSAE MAJORIS—						
	3721.6	12.6	Wf.	3741.9	12.3	Pt.
123307 R VIRGINIS—						
	3741.9	10.6	Pt.			
123459 RS URSAE MAJORIS—						
	3709.7	8.7	Sg,	3721.6	8.6	Wf,
	3711.4	8.8	Ch.	3741.9	8.5	Pt,
	3713.5	8.5	Ca,	3743.9	9.3	Cy,
	3719.5	8.4	Cd,	3752.7	9.3	Cu.
123961 S URSAE MAJORIS—						
	3720.5	12.0	Cd,	3741.9	10.4	B,
	3721.6	11.3	Wf,	3752.7	9.6	Cu.
	3724.3	11.7	L.			
131283 U OCTANTIS—						
	3682.9	9.3	Bl.			
132422 R HYDRAE—						
	3682.9	8.8	Bl.			
133273 T URSAE MINORIS—						
	3721.6	13.5	Wf.			
133633 T CENTAURI—						
	3682.9	6.0	Bl.			
134236 RT CENTAURI—						
	3682.9	9.4	Bl.			
134440 R CANUM VENATICORUM—						
	3734.5	10.1	Cu.	3741.9	10.1	Pt.
134617 T APODIS—						
	3682.9	12.5	Bl.			

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
140959 R CENTAURI—						
	3684.9	7.8	Bl.			
141567 U URSAE MINORIS—						
	3708.0	11.5	Ch,	3734.5	10.9	O,
	3712.7	11.5	Br,	3752.6	10.2	Cu.
	3721.5	11.5	Pt,			
141954 S BOOTIS—						
	3721.3	12.1	L,	3721.6	11.8	Wf,
	3721.3	12.2	Lh,	3728.6	11.5	Sg.
142539 V BOOTIS—						
	3690.9	8.3	Kd,	3721.5	7.9	Pt,
	3715.5	7.9	Ca,	3724.4	8.1	Ca,
	3717.7	8.0	Sg,	3725.5	8.7	Ly,
	3719.5	8.4	Ly,	3728.8	8.4	Sg.
	3721.3	7.9	L,			
142584 R CAMELOPARDIS—						
	3721.5	8.4	Pt,	3736.6	8.4	Cu,
	3721.6	8.6	Wf,	3752.6	8.2	Cu.
	3725.5	8.7	O,			
143227 R BOOTIS—						
	3701.5	7.3	Ie,	3721.5	6.8	Pt.
	3715.5	6.8	Ca,			
145971 S APODIS—						
	3684.9	9.8	Bl.			
151714 S SERPENTIS—						
	3711.3	9.9	L,	3721.5	9.5	Pt,
	3711.3	9.7	Lh,	3721.6	9.9	Wf.
151731 S CORONAE BOREALIS—						
	3721.5	8.9	Pt,	3727.5	8.4	Ca,
	3721.6	9.0	Wf,	3728.6	7.6	Sg,
	3722.5	9.2	Cd,	3736.5	7.3	Ca.
151822 RS LIBRAE—						
	3684.9	9.8	Bl.			
152849 R NORMAE—						
	3684.9	11.6	Bl.			
153020 X LIBRAE—						
	3684.9	11.4	Bl.			
153215 W LIBRAE—						
	3684.9	11.6	Bl.			
153378 S URSAE MINORIS—						
	3710.6	11.5	Cy,	3735.5	10.8	Ro,
	3721.5	11.5	Pt,	3737.8	11.5	Sg,
	3721.6	11.4	Wf,	3744.5	11.8	Cy,
	3723.7	11.6	Sg,			
154428 R CORONAE BOREALIS—						
	3673.9	6.4	Kd,	3724.4	6.3	Ca,
	3683.5	6.3	Mh,	3724.5	6.2	Pt,
	3692.1	6.3	Ch,	3724.6	6.2	Wf,
	3693.1	6.3	Ch,	3725.2	6.5	Lh,
	3694.5	5.8	Ie,	3725.2	6.1	L,
	3696.9	6.4	Kd,	3725.5	6.5	Cu,
	3700.3	6.1	Lh,	3725.5	6.2	Pt,
	3700.3	6.2	L,	3725.5	6.0	Ly,
	3700.6	6.6	Mh	3725.6	6.0	Sg,
	3701.5	6.0	Ie,	3726.5	6.3	Ca,
	3704.3	6.4	Lh,	3726.5	6.2	Pt,
	3704.3	6.3	L,	3727.5	6.5	Ca,
	3704.9	6.4	Kd,	3727.5	6.4	Cy,
	3707.0	6.5	Ch,	3728.5	6.1	Cd,
	3708.5	6.0	Ie,	3728.6	6.0	Sg,
	3708.9	6.2	Kd,	3732.5	6.5	Gb,

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
154428 R CORONAE BOREALIS—Cont.						
	3709.5	6.6	Cy,	3733.5	6.3	Pt,
	3709.7	6.2	Sg,	3733.5	6.3	Cy,
	3711.2	6.3	L,	3734.5	6.0	Ly,
	3711.2	6.4	Lh,	3734.3	6.3	Ca,
	3712.1	6.3	Ch,	3734.5	6.6	Ms,
	3713.0	6.3	Ch,	3734.5	6.7	Kl,
	3713.5	6.4	Ca,	3734.5	6.5	Cu,
	3715.5	6.4	Ca,	3734.5	6.2	Pt,
	3715.5	6.7	Cd,	3735.5	6.2	Pt,
	3715.5	6.2	Pt,	3736.5	6.2	Pt,
	3715.9	6.3	Kd,	3736.5	6.4	Cu,
	3718.5	6.2	Pt,	3736.5	6.3	Ca,
	3719.5	6.4	Ca,	3736.5	6.6	Ms,
	3619.5	6.6	Cy,	3737.5	6.3	Pt,
	3720.0	6.3	Ch,	3737.6	6.0	Sg,
	3720.6	6.5	Wf,	3741.9	6.2	Pt,
	3720.4	6.4	Ca,	3743.5	6.4	Cy,
	3721.2	6.1	L,	3743.5	6.5	Ms,
	3721.5	6.3	Pt,	3744.5	6.8	Ms,
	3721.2	6.3	Lh,	3752.5	6.4	Cu,
	3721.6	6.3	Wf,	3755.5	6.5	Ms,
	3723.6	6.3	Wf,	3757.5	6.8	Ms.
154536 X CORONAE BOREALIS—						
	3721.5	9.7	Pt,	3724.6	10.7	Wf.
154639 V CORONAE BOREALIS—						
	3713.5	6.9	Ca,	3721.5	6.9	Pt,
	3721.5	7.0	Ca,	3723.6	8.0	Wf.
160021 Z SCORPII—						
	3684.9	10.6	Bl.			
160210 U SERPENTIS—						
	3721.5	10.3	Pt.			
160625a RU HERCULIS—						
	3704.3	13.9	L,	3723.6	13.2	Wf.
	3721.5	13.4	Pt.			
160625b SX HERCULIS—						
	3711.3	8.0	L,	3724.5	7.8	Pt,
	3715.5	7.9	Pt,	3724.6	7.8	Wf,
	3718.5	7.8	Pt,	3726.5	7.9	Pt,
	3721.5	7.7	Pt,	3733.5	8.0	Pt,
	3723.6	7.9	Wf,	3736.5	8.2	Pt.
161122a R SCORPII—						
	3684.9	10.9	Bl.			
161122b S SCORPII—						
	3684.9	10.8	Bl.			
161138 W CORONAE BOREALIS—						
	3715.5	8.8	Ca,	3721.6	9.5	Wf,
	3721.5	9.2	Pt,	3722.5	9.2	Cd,
162119 U HERCULIS—						
	3695.5	11.8	Ie,	3724.5	12.5	Pt.
	3721.6	12.0	Wf.			
162807 SS HERCULIS—						
	3121.3	10.9	L,	3724.5	10.9	Pt.
	3721.3	11.0	Lh,			
163137 W HERCULIS—						
	3692.1	11.1	Ch,	3724.5	8.7	Ca,
	3705.1	10.8	Ch,	3724.5	8.4	Pt,
	3713.6	9.3	B,	3735.5	8.0	M.
	3715.0	9.4	Ch,			
163172 R URSAE MINORIS—						
	3719.5	9.8	B.			

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
163266 R DRACONIS—						
	3708.0	10.5	Ch.	3719.5	10.8	B.
	3715.6	10.0	Ca.	3724.5	11.1	Pt.
164715 S HERCULIS—						
	3705.1	7.5	Ch.	3724.5	7.9	Pt.
	3715.1	7.5	Ch.	3724.5	8.5	O.
	3715.5	7.4	Ca.	3736.5	8.2	Ca.
	3718.5	7.9	B.			
164844 RS SCORPII—						
	3684.9	9.1	Bl.			
165030 RR SCORPII—						
	3684.9	7.0	Bl.	3690.9	7.1	Kd.
165631 RV HERCULIS—						
	3735.5	14.3	M.			
165636 RT SCORPII—						
	3684.9	12.3	Bl.			
170215 R OPHIUCHI—						
	3694.5	7.0	Ie.	3719.5	8.6	Ca.
	3705.1	7.5	Ch.	3724.5	8.4	Pt.
	3713.0	8.0	Ch.			
170627 RT HERCULIS—						
	3721.6	13.0	Wf.	3724.5	13.5	Pt.
171401 Z OPHIUCHI—						
	3713.5	9.4	Ya.	3724.5	8.4	Pt.
	3719.5	9.1	Ca.	3724.5	9.2	O.
171723 RS HERCULIS—						
	3121.6	12.3	Wf.	3724.5	12.6	Pt.
172486 S OCTANTIS—						
	3686.9	9.6	Bl.			
172809 RU OPHIUCHI—						
	3724.5	13.5	Pt.			
173212 RT SERPENTIS—						
	3704.3	9.5	L.	3704.3	9.5	Lh.
173543 RU SCORPII—						
	3685.0	9.3	Bl.			
174162 W PAVONIS—						
	3685.0	9.7	Bl.			
175458a T DRACONIS—						
	3720.5	11.2	B.	3737.5	11.1	B.
175458b UY DRACONIS—						
	3737.5	10.7	B.			
175519 RY HERCULIS—						
	3705.1	11.3	Ch.	3718.5	9.9	B.
	3715.1	10.4	Ch.	3724.5	9.4	Pt.
180531 T HERCULIS—						
	3692.1	8.3	Ch.	3725.5	9.1	Pt.
	3695.5	8.3	Ie.	3725.6	9.2	B.
	3707.3	8.9	Pe.	3725.6	9.2	Ly.
	3709.5	8.3	Ie.	3726.5	9.2	Ly.
	3709.7	8.0	Sg.	3726.6	9.1	Sg.
	3711.3	8.4	L.	3727.5	8.8	Ca.
	3712.1	8.4	Ch.	3734.5	9.0	Ca.
	3713.6	8.5	B.	3734.5	9.6	Ly.
	3715.5	8.6	Cd.	3734.5	9.6	Ya.
	3715.6	8.5	Ca.	3736.6	9.5	Cu.
	3720.5	8.5	Cd.	3738.6	9.9	Sg.
	3721.6	8.8	Ly.	3755.5	11.2	Ms.
	3723.6	9.2	Wf.	3757.5	11.1	Ms.
	3724.5	8.8	O.			
180565 W DRACONIS—						
	3725.6	9.7	B.	3738.5	9.4	Ya.
	3725.5	9.7	Pt.			
180666 X DRACONIS—						
	3713.6	11.2	B.	3725.6	11.0	B.
180911 NOVA OPHIUCHI #4—						
	3725.5	13.2	Pt.			
181031 TV HERCULIS—						
	3725.3	12.0	L.			
181103 RY OPHIUCHI—						
	3713.5	8.6	Ca.	3725.5	10.0	Pt.
	3720.6	8.9	Wf.	3734.5	11.0	B.
	3724 6	9.6	Wf.			
181136 W LYRAE—						
	3710.8	9.6	Sg.	3725.3	10.4	L.
	3711.3	10.1	L.	3725.3	10.4	Lh.
	3713.3	9.9	Lh.	3725.5	11.1	Pt.
	3719.6	10.3	B.	3727.7	11.0	Ct.
	3720.6	10.1	Wf.	3730.6	11.0	Sg.
	3720.7	10.7	Sg.	3731.7	11.5	Ct.
	3724.5	10.3	Ca.	3734.5	11.8	B.
	3724.5	10.3	O.	3738.6	11.0	Sg.
	3724.6	10.4	Wf.			
182133 RV SAGITTARII—						
	3686.9	13.0	Bl.			
182224 SV HERCULIS—						
	3711.3	10.7	L.	3720.6	11.0	B.
	3711.3	10.7	Lh.	3734.5	12.1	B.
182306 T SERPENTIS—						
	3736.5	12.7	B.			
183225 RZ HERCULIS—						
	3725.5	12.1	Pt.			
183308 X OPHIUCHI—						
	3704.3	8.5	L.	3725.5	8.1	Ly.
	3713.5	8.0	B.	3725.6	7.9	Ya.
	3718.6	8.2	B.	3726.5	8.0	Ly.
	3721.6	8.2	Ly.	3734.5	8.0	Ly.
	3724.5	8.0	O.			
184205 R SCUTI—						
	3665.5	5.5	Ie.	3726.5	5.9	Pt.
	3673.9	5.7	Kd.	3726.5	5.7	Ly.
	3692.1	6.0	Ch.	3727.5	5.8	Cy.
	3696.9	5.5	Kd.	3727.5	5.7	Ca.
	3700.6	6.0	Mh.	3727.5	5.7	Ct.
	3702.4	5.0	Lh.	3728.5	5.9	Cd.
	3702.4	5.2	L.	3728.6	6.0	Sg.
	3704.9	5.7	Kd.	3731.7	5.8	Ct.
	3705.1	5.8	Ch.	3732.6	6.0	Gb.
	3707.1	5.7	Ch.	3733.5	6.2	Ms.
	3708.5	5.6	Ie.	3733.5	6.2	O.
	3708.9	5.6	Kd.	3733.5	6.0	Pt.
	3709.5	5.8	Cy.	3733.5	6.0	Cy.
	3709.7	5.6	Sg.	3734.5	6.0	Pt.
	3710.9	5.8	Kd.	3734.5	6.1	Ms.
	3712.3	5.6	Lh.	3734.5	5.7	Ca.
	3712.3	5.5	L.	3734.5	6.0	Kl.
	3713.1	5.7	Ch.	3734.5	6.1	Ly.
	3713.5	5.5	Ca.	3734.5	5.5	Cu.
	3713.9	5.8	Kd.	3735.5	6.2	Ms.
	3715.5	5.6	Cd.	3735.5	6.1	Pt.
	3715.5	5.6	Ca.	3736.5	6.0	Pt.

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Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
181205 R SCUTI—Continued.						
	3715.5	5.6	Pt.	3736.5	5.9	Cu.
	3718.5	5.5	Pt.	3736.5	6.0	Cd.
	3719.5	5.7	Ly.	3736.5	5.7	Ca.
	3719.5	5.6	Ca.	3736.5	6.2	Ms.
	3719.5	5.8	Cy.	3736.5	6.2	Cu.
	3720.5	5.6	Ca.	3737.5	6.0	Pt.
	3720.7	5.5	Sg.	3743.5	6.0	Cy.
	3721.5	5.8	Pt.	3743.5	6.3	Ms.
	3724.5	5.9	Pt.	3744.5	6.1	Cu.
	3724.5	5.6	Ca.	3744.5	6.2	Ms.
	3724.5	6.1	O.	3751.5	6.3	Ms.
	3724.5	5.6	Ie.	3751.5	5.5	Cu.
	3725.5	5.8	Ly.	3752.5	6.1	Cu.
	3725.5	5.7	Ya.	3752.5	6.3	Ms.
	3725.5	6.0	Pt.	3755.5	6.5	Ms.
	3725.5	6.5	Cu.	3757.5	6.5	Ms.
	3726.5	5.6	Ca.	3758.5	6.7	Ms.
184300 NOVA AQUILAE #3—						
	3704.3	10.3	L.	3724.5	10.4	Ca.
	3703.3	10.3	Lh.	3724.5	10.3	Ie.
	3705.1	10.2	Ch.	3725.5	10.0	Ya.
	3720.6	10.4	B.	3733.5	9.8	Pt.
	3720.7	10.3	Sg.	3735.5	10.1	Ro.
185032 RX LYRAE—						
	3705.1	11.7	Ch.	3725.5	11.7	Pt.
	3715.1	11.6	Ch.	3735.5	11.5	M.
185437 S CRUCIS AUS.—						
	3686.9	11.7	Bl.			
*185537*a R CRUCIS AUS.—						
	3686.9	13.0	Bl.			
185737 RT LYRAE—						
	3738.5	10.2	Pi.			
190108 R AQUILAE—						
	3693.7	11.0	Ch.	3727.5	11.5	Ca.
	3719.6	11.5	B.	3737.6	11.5	B.
	3725.5	11.6	Pt.			
190818 RX SAGITTARII—						
	3707.1	12.0	Ch.	3725.5	11.9	Pt.
	3713.6	12.2	B.	3735.5	11.5	B.
	3720.0	11.5	Ch.			
*190819*a RW SAGITTARII—						
	3705.1	10.2	Ch.	3725.5	10.0	Pt.
	3713.6	10.4	B.	3733.5	10.2	B.
	3720.0	10.6	Ch.			
190907 TY AQUILAE—						
	3725.5	10.5	Pt.			
190925 S LYRAE—						
	3725.3	14.2	L.	3735.5	14.0	M.
	3725.5	13.7	Pt.			
190926 X LYRAE—						
	3725.5	8.6	Pt.			
190933a RS LYRAE—						
	3725.5	13.2	Pt.			
190941 RU LYRAE—						
	3725.5	10.8	Pt.	3738.5	10.8	Pi.
	3725.8	11.0	Pa.			
190967a U DRACONIS—						
	3692.1	10.4	Ch.	3725.5	9.6	Pt.
	3714.2	9.5	Ch.	3725.6	9.3	Hu.
191017 T SAGITTARII—						
	3707.1	11.5	Ch.	3726.5	11.4	Pt.
191019 R SAGITTARII—						
	3707.1	9.9	Ch.	3720.5	8.8	B.
	3718.7	8.6	Sg.	3726.5	8.0	B.
	3719.5	8.7	Ca.	3738.5	8.1	Ya.
	3720.0	9.4	Ch.			
191033 RY SAGITTARII—						
	3684.9	9.5	Bl.	3721.2	10.8	L.
	3686.9	10.0	Bl.	3721.2	10.9	Lh.
	3692.1	10.5	Ch.	3721.5	11.4	Pt.
	3692.9	9.9	Bl.	3724.5	11.5	Pt.
	3704.5	10.6	L.	3725.2	11.0	L.
	3707.0	10.5	Ch.	3725.5	11.5	Pt.
	3715.5	10.0	Pt.	3735.5	11.6	Pt.
	3718.5	10.1	Pt.	3734.5	11.4	Pt.
	3720.0	11.5	Ch.			
191350 TZ CYGNI—						
	3725.6	11.0	Pt.	3738.5	11.1	Pi.
191637 U LYRAE—						
	3725.6	10.7	Pt.	3738.5	10.6	Pi.
192928 TY CYGNI—						
	3693.2	10.5	Ch.	3725.6	9.5	Pt.
	3714.2	9.8	Ch.			
193311 RT AQUILAE—						
	3725.6	12.5	Pt.	3733.6	13.0	B.
193449 R CYGNI						
	3696.3	9.9	Ch.	3732.7	10.1	Bw.
	3710.6	10.4	Cy.	3733.7	11.2	Kl.
	3713.6	10.2	Hr.	3734.5	11.3	Ly.
	3719.6	9.8	B.	3734.6	11.3	Sg.
	3719.7	10.1	Ca.	3735.6	11.5	Cy.
	3720.6	10.4	Cy.	3736.6	10.0	Ms.
	3720.6	10.5	Hr.	3736.6	9.8	B.
	3720.6	10.6	Wf.	3738.5	11.8	Pi.
	3720.7	10.3	Sg.	3741.7	11.4	Kl.
	3725.6	10.1	Bw.	3743.5	11.5	Cy.
	3725.6	10.1	Pt.	3743.6	10.0	Ms.
	3725.6	10.0	Hu.	3749.5	11.8	Cy.
	3726.6	11.3	Ly.	3752.5	10.5	Ms.
	3728.7	11.3	Kl.	3755.5	11.1	Ms.
	3731.7	11.3	Ct.			
193509 RV AQUILAE—						
	3725.6	13.9	Pt.			
193732 TT CYGNI—						
	3725.6	7.2	Hu.			
193972 T PAVONIS—						
	3636.0	12.1	Bl.	3657.0	13.2	Bl.
194048 RT CYGNI—						
	3696.2	8.2	Ch.	3726.6	9.8	Pi.
	3719.6	8.9	B.	3731.7	10.4	Ct.
	3720.7	9.5	Sg.	3734.6	11.0	Sg.
	3721.6	9.6	Ca.	3736.6	9.8	B.
	3725.6	9.4	Pt.	3737.6	9.9	B.
	3725.6	9.2	Hu.	3752.5	10.8	Ms.
194348 TU CYGNI—						
	3696.2	9.2	Ch.	3726.6	10.1	Pi.
	3619.6	9.8	B.	3736.6	10.6	B.
	3625.6	10.2	Pt.	3737.6	10.7	B.
	3625.6	10.3	Hu.			

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
194604 X AQUILAE—						
	3720.6	13.2	Wf.	3724.6	13.3	B.
	3723.6	13.2	Wf.			
194632 χ CYGNI—						
	3692.1	6.6	Ch.	3725.6	4.7	Pt.
	3692.2	6.3	Ch.	3725.6	6.0	Hu.
	3693.2	6.3	Ch.	3725.6	5.0	Cu.
	3695.2	6.2	Ch.	3727.7	4.5	Ct.
	3695.2	6.5	Ch.	3729.5	5.1	Cu.
	3696.9	5.7	Kd.	3731.5	4.6	Ms.
	3702.1	5.6	Kd.	3731.7	4.5	Ct.
	3702.1	6.0	Ch.	3733.5	4.6	Ms.
	3704.0	5.3	Kd.	3734.5	4.6	Ms.
	3705.0	5.3	Kd.	3734.5	4.7	Ca.
	3705.1	5.9	Ch.	3734.5	4.9	Cu.
	3707.3	5.1	Pe.	3734.6	4.0	Ya.
	3708.9	5.2	Kd.	3735.5	4.8	Ms.
	3709.3	5.0	Pe.	3736.5	4.7	Ms.
	3710.3	5.2	Pe.	3736.5	5.0	Cu.
	3711.0	5.2	Kd.	3743.5	5.2	Cu.
	3712.0	5.1	Kd.	3743.5	4.7	Ms.
	3712.1	5.2	Ch.	3744.5	4.4	Ms.
	3713.2	5.1	Ch.	3744.5	5.2	Cu.
	3713.7	5.0	Ca.	3749.5	5.1	Cu.
	3713.9	5.1	Kd.	3750 4	5.4	Cu.
	3716.0	5.0	Kd.	3751.5	5.2	Cu.
	3718.1	5.0	Ch.	3751.5	5.0	Ms.
	3718.6	4.8	B.	3752.5	5.1	Cu.
	3719.6	4.8	Ca.	3752.5	5.5	Ms.
	3720.1	4.9	Ch.	3755.5	5.7	Ms.
	3723.3	4.9	Pe.	3757.5	5.7	Ms.
	3724.5	4.7	Ca.	3758.5	5.8	Ms.
194929 RR SAGITTARII—						
	3686.9	10.4	Bl.			
195122 RU SAGITTARII—						
	3686.9	7.1	Bl.			
195202 RR AQUILAE—						
	3724.6	12.5	B.	3725.6	12.0	Pt.
195308 RS AQUILAE—						
	3718.6	9.7	B.	3725.6	10.2	Pt.
195553 NOVA CYGNI 23—						
	3703.2	11.0	Ch.	3726.6	12.0	Pi.
	3718.5	11.2	Pt.	3733.6	11.4	Pt.
	3718.7	10.9	B.	3733.6	11.8	B.
	3721.5	11.2	Pt.	3737.6	10.4	B.
	3724.5	11.2	Pt.			
195849 Z CYGNI—						
	3703.2	10 4	Ch.	3725.6	9.4	Pt.
	3715.1	9.6	Ch.	3726.6	10.2	Pi.
	3720.6	10.0	Wf.	3734.6	10.0	Ya.
	3722.7	9.8	B.	3737.6	9.6	B.
200212 SY AQUILAE—						
	3726.6	12.8	B.	3733.6	12.9	B.
	3725.2	13.5	L.	3736.6	13.0	B.
	3726.5	13.2	Pt.			
200357 S CYGNI—						
	3712.7	13.2	Br.	3722.7	13.0	Sg.
	3718.6	12.9	B.	3724.6	11.3	Wf.
	3719.7	13.0	Br.	3733.6	12.6	B.
	3720.6	12.9	Wf.	3736.6	9.2	Ya.
200514 R CAPRICORNI—						
	3716.6	11.5	B.	3733.5	12.3	O.
	3726.5	12.2	Pt.			
200647 SV CYGNI—						
	3725.6	8.5	Hu.	3738.6	8.7	B.
200715a S AQUILAE—						
	3707.2	11.7	Ch.	3724.6	11.3	Wf.
	3718.6	11.3	B.	3726.5	10.9	Pt.
	3720.6	11.2	Wf.			
200715b RW AQUILAE—						
	3718.6	9.2	B.	3735.5	9.2	Ya.
	3726.5	9.1	Pt.			
200717 R TELESCOPII—						
	3686.9	13.5	Bl.			
200812 RU AQUILAE—						
	3719.6	11.8	B.	3734.6	11.1	B.
	3724.5	12.0	O.			
200906 Z AQUILAE—						
	3719.6	10.5	B.	3736.6	12.0	B.
	3726.5	11.0	Pt.			
200916 R SAGITTAE—						
	3718.6	9.1	B.	3736.5	9.0	Ya.
200938 RS CYGNI—						
	3692.2	8.5	Ch.	3726.6	7.5	Pi.
	3695 2	7.8	Ch.	3726.6	7.6	Ly.
	3703.2	7.4	Ch.	3727.6	7.6	Cy.
	3711.3	7.1	L.	3734.6	7.0	Sg.
	3711.3	7.4	Lh.	3736.6	7.5	Ya.
	3714.2	7.2	Ch.	3744.5	7.7	Cy.
	3721.6	7.5	Ly.	3751.7	7.0	Sg.
	3726.5	7.1	Pt.			
201008 R DELPHINI—						
	3704.3	12.3	L.	3726.7	12.0	Pt.
	3722.6	12.0	B.	3734.4	11.4	B.
	3723.6	11.9	Wf.	3738.5	11.2	Ya.
	3724.5	12.0	Ie.			
201121 RT CAPRICORNI—						
	3696.9	7.3	Kd.	3726.7	6.3	Pt.
	3704.3	6.4	L.			
201139 RT SAGITTARII—						
	3686.9	10.0	Bl.	3733.5	7.1	Pt.
201437b WX CYGNI—						
	3692.2	10.3	Ch.	3728.7	10.7	Kl.
	3695.2	10.4	Ch.	3733.7	10.7	Kl.
	3719.6	10.5	Pi.	3734.6	10.5	Sg.
	3719.6	9.4	B.	3736.6	9.4	B.
	3720.6	10.4	Wf.	3741.7	10 8	Kl.
	3720.7	9.8	Sg.	3744.5	11.0	Cy.
	3726.7	10.7	Pt.			
201647 U CYGNI—						
	3719.7	8.2	Ca.	3734.6	8.4	Ya.
	3720.7	7.8	Sg.	3734.6	9.5	Sg.
	3722.6	8.0	B.	3735.5	8.2	Ro.
	3726.6	9.4	Pi.	3736.5	8.4	Ro.
	3726.7	8.2	Pt.	3737.6	8.3	B.
	3731.7	9.4	Ct.	3751.6	9.4	Cu.
202817 Z DELPHINI—						
	3718.6	11.2	B.	3726.7	10.4	Pt.
	3723.6	10.6	Wf.	3734.6	10.0	B.
	3724.5	10.9	O.	3736.6	10.1	Pi.

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
202946 SZ CYGNI—						
	3713.7	8.8	Pt,	3726.7	8.9	Pt,
	3715.5	9.6	Pt,	3733.6	9 8	Pt,
	3718.5	10.4	Pt,	3736.5	9.9	Pt.
	3721.5	9.5	Pt,	3737.6	9.7	B,
	3722.7	9.6	B,	3741.7	9.1	Pt.
	3724.5	8.9	Pt.			
202954 ST CYGNI—						
	3718.6	11.3	B,	3726.7	11.5	Pt,
	3719.5	11.7	Pi,	3737.6	11.2	B.
	3725.6	11.5	Hu.			
203226 V VULPECULAE—						
	3726.7	8.7	Pt.			
203816 S DELPHINI—						
	3718.6	9.7	B,	3726.7	10.0	Pt,
	3724.5	10.4	O,	3736 6	10.7	Pi,
	3725.6	10.0	Hu,	3738.6	10.2	B.
203847 V CYGNI—						
	3696.2	9.7	Ch,	3722.7	7.9	Ca,
	3697.8	8.7	Pa,	3726.5	9.0	Pi,
	3715.1	8.8	Ch,	3726.7	7.0	Pt,
	3718.6	8.0	B,	3731.7	9.0	Ct,
	3720.6	8.4	Wf,	3737.6	7.5	B.
203905 Y AQUARII—						
	3707.2	11.0	Ch,	3726.7	12.0	Pt,
	3716.6	11.1	B,			
204016 T DELPHINI—						
	3656.2	9.6	Ch,	3725.6	9.8	Hu,
	3715.2	9.4	Ch,	3725.6	9.4	B,
	3720.6	9.4	Wf,	3726.7	9.4	Pt,
	3720.7	9.4	Sg,	3734.7	9.8	Sσ.
	3724.5	9.5	Ie,	3736.6	9.5	Pi.
204102 V AQUARII—						
	3707.2	9.1	Ch,	3726.7	8.2	Pt.
	3716.5	8.7	B,			
204104 W AQUARII—						
	3704.3	13.0	L,	3736.5	13.6	B.
	3704.3	12.6	Lh,			
204405 T AQUARII—						
	3716.5	11.6	B,	3725.6	11.5	Hu,
	3720.5	11.7	Ca,	3726.7	11.2	Pt.
204846 RZ CYGNI—						
	3697.8	12.4	Pa,	3725.8	11.8	Pa,
	3719.6	11.5	B.	3726.5	11.9	Pi,
	3723.6	11.9	Wf,	3726.7	11.7	Pt,
	3723.7	12.2	Sg,	3736.6	11.2	B.
	3725.6	11.6	Bw.			
205923 R VULPECULAE—						
	3707.2	9.5	Ch,	3725.6	8.3	B,
	3713.6	9.1	B,	3725.6	7.8	Hu,
	3720.6	7.9	Wf,	3726.7	8.0	Pt,
	3724.6	9.3	Wf,	3736.5	8.5	Pi.
200129 TW CYGNI—						
	3697.8	13.0	Pa,	3736.6	10.4	B.
	3719.6	11.3	B,			
210382 X CEPHEI—						
	3716.8	[14.2	Pa,	3725.8	[14.2	Pa,
	3725.6	[14.0	Bw,	3732.8	15.4	Pa.
210504 RS AQUARII—						
	3711.3	10.5	L,	3726.7	10.8	Pt.
	3716.6	10.6	B,			
210516 Z CAPRICORNI—						
	3716.6	12.1	B.			
210812 R EQUULEI—						
	3723.6	11.4	Wf,	3733.5	12.2	O,
	3726.7	11.6	Pt,	3736.6	12.0	B.
	3727.6	11.5	Br,			
210868 T CEPHEI—						
	3695.2	9.5	Ch,	3726.7	9.7	Pt,
	3702.6	9.7	L,	3727.7	9.8	Sg,
	3713.6	9.4	B,	3728.7	10.3	Kl,
	3722.7	10.0	Ca,	3728.8	9.9	Ke,
	3725.6	9.5	B,	3733.7	10.1	Kl,
	3725.7	9.9	L,	3741.7	10.2	Kl.
210903 RR AQUARII—						
	3716.6	10.9	B,	3726.7	11.6	Pt,
	3719.6	11.0	Br,	3727.6	11.7	Br.
211614 X PEGASI—						
	3720.6	11.9	Wf,	3736.5	11.6	Pi,
	3724.7	11.7	Wf,	3737.6	11.0	B,
	3726.7	11.2	Pt.			
211615 T CAPRICORNI—						
	3687.0	11.7	Bl.			
213811 Y CAPRICORNI—						
	3705.2	10.8	Ch,	3735.6	12.6	B.
213244 W CYGNI—						
	3690.9	6.4	Kd,	3712.3	5.9	L,
	3696.9	6.4	Kd,	3713.9	6.6	Kd,
	3704.0	6.5	Kd,	3736.5	6.1	Cu,
	3710.1	6.6	Kd,	3749.6	5.9	Cu.
213678 S CEPHEI—						
	3713.6	8.5	B,	3734.6	8.2	Hu,
	3725.6	8.5	B,	3752.5	9.2	Cu.
	3726.7	8.3	Pt,			
213753 RU CYGNI—						
	3707.2	8.3	Ch,	3726.7	8.0	Pt.
213843 SS CYGNI—						
	3692.2	8.6	Ch,	3724.5	11.7	Pt,
	3693.1	8.4	Ch,	3724.5	11.5	Ie,
	3694.5	8.8	Ie,	3724.7	11.6	Wf,
	3695.2	8.8	Ch,	3725.2	11.4	L,
	3695.6	9.0	Ie,	3725.2	11.5	Lh,
	3696.2	9.0	Ch,	3725.5	11.8	Pt,
	3696.5	9.4	Ie,	3725.6	]9.6	Cu,
	3699.5	10.3	Ie,	3625.6	11.9	Hu,
	3700.3	10.2	L,	3725.7	11.6	B,
	3700.5	10.7	Ie,	3726.5	11.8	Pt,
	3701.2	11.4	Ch,	3726.5	11.8	Pi,
	3701.5	11.2	Ie,	3726.5	11.8	Bi,
	3702.3	11.8	L,	3727.5	11.9	Pi,
	3702.4	12.1	Lh,	3727.6	12.0	Br,
	3702.5	11.6	Ie,	3727.6	11.9	Ca.
213843 SS CYGNI—						
	3704.3	11.4	L,	3727.6	11.8	Ly,
	3704.3	11.5	Lh,	3728.7	11.8	Kl,
	3705.2	11.7	Ch,	3729.5	]9.6	Cu,
	3706.3	11.9	Ch,	3729.8	11.2	Sg,
	3706.7	11.8	Br,	3730.7	11.9	Kl,
	3707.7	11.9	Ch,	3731.6	11.6	B,
	3707.6	11.5	Br,	3732.6	11.2	Br,
	3708.5	11.7	Ie,	3733.5	9.1	Cd,
	3709.5	11.7	Ie,	3733.6	8.9	B,

VARIABLE STAR OBSERVATIONS, October 20 to November 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—Continued.						
	3710.6	11.5	Wf,	3733.6	8.8	Pt,
	3710.8	12.0	Sg,	3733.7	8.9	Kl,
	3711.2	11.4	L,	3733.7	8.8	Kl,
	3711.2	11.3	Lh,	3734.5	8.9	Ha,
	3712.2	11.5	L,	3734.5	8.9	Ht,
	3712.2	11.4	Lh,	3734.5	8.6	Cu,
	3712.6	11.4	Br,	3734.5	8.7	Pt,
	3712.7	11.4	B,	3734.6	8.7	Ms,
	3713.3	11.5	L,	3734.6	8.6	Ly,
	3713.3	11.5	Lh,	3734.6	8.6	Ae,
	3713.5	11.5	Ie,	3734.6	8.7	Pi,
	3713.6	11.4	B,	3734.6	8.7	B,
	3713.7	11.7	Pt,	3734.6	8.5	Kl,
	3714.2	11.7	Ch,	3734.7	8.8	Sg,
	3714.5	11.3	Ie,	3735.5	9.0	Pt,
	3714.8	11.8	Pt,	3735.5	8.6	Ro,
	3715.2	[11.9	Ch,	3735.6	8.7	Pi,
	3715.5	11.7	Cd,	3735.6	9.0	Kl,
	3715.5	11.8	Pt,	3735.7	8.8	B,
	3715.6	11.6	Br,	3735.7	8.9	Ca,
	3716.6	11.7	Br,	3736.5	8.8	Cu,
	3716.6	11.3	B,	3736.5	9.0	Cd,
	3716.7	11.3	Wf,	3736.5	9.0	Pi,
	3717.7	11.3	Br,	3736.5	8.8	Ms,
	3718.2	11.7	Ch,	3736.5	9.3	Ht,
	3718.5	11.7	Pt,	3736.5	9.2	Pt,
	3718.6	11.4	B,	3736.5	9.3	Ha,
	3718.6	11.7	Br,	3736.6	9.2	Ro,
	3719.2	[10.9	Ch,	3736.6	9.0	O,
	3719.5	[11.3	Pi,	3736.6	9.0	Cu,
	3719.5	11.9	Cd,	3736.6	8.8	B,
	3719.6	11.9	Wf,	3737.5	9.4	Pt,
	3719.5	11.5	B,	3737.6	9.1	B,
	3719.7	11.8	Br,	3737.7	9.5	Sg,
	3719.7	11.6	Ca,	3738.5	9.5	Pi,
	3720.1	11.8	Ca,	3738.6	9.5	Ya,
	3720.5	[11.3	Pi,	3738.6	9.6	B,
	3720.6	11.6	B,	3738.8	10.0	Sg,
	3720.6	11.8	Wf,	3739.6	9.9	B,
	3720.6	11.0	Sg,	3741.5	[10.0	Ya,
	3720.6	11.2	Br,	3741.7	10.9	Kl,
	3721.1	11.7	Ch,	3741.7	10.4	Pt,
	3721.2	11.5	Lh,	3742.6	11.3	Kl,
	3721.2	11.5	L,	3743.5	[10.9	Ms,
	3721.5	11.8	Pt,	3743.6	11.7	Kl,
	3721.6	11.7	Br,	3744.5	]9.6	Cu,
	3121.6	11.5	Ly,	3744.5	11.6	Cy,
	3721.6	11.9	Ie,	3151.5	]9.6	Cu,
	3721.7	11.8	Wf,	3751.5	11.2	Ms,
	3722.9	11.6	B,	3752.5	]9.6	Cu,
	3723.1	11.8	Ch,	3752.5	11.0	Ms,
	3723.3	12.0	L,	3753.5	]9.6	Cu,
	3723.5	[11.3	Pi,	3755.5	11.8	Ms,
	3723.6	11.8	Wf,	3757.5	11.7	Ms,
	3723.7	11.6	Sg,	3758.5	11.7	Ms.
213937 RV CYGNI—						
	3725.6	7.0	Hu,	3738.6	7.6	B,
	3726.7	6.3	Pt,			
214024 RR PEGASI—						
	3720.6	12.8	Br,	3726.7	13.2	Pt,
	3723.6	13.2	Wf,	3734.6	13.3	B.
124247 R GRUIS—						
	3687.0	8.3	Bl.			
215605 Y PEGASI—						
	3720.6	11.2	Br,	3726.7	11.2	Pt,
	3723.6	11.1	Wf,	3736.6	11.8	B.
215717 U AQUARII—						
	3720.6	11.8	Br,	3734.5	11.5	B.
	3726.7	12.0	Pt,			
215934 RT PEGASI—						
	3711.8	11.3	Sg,	3734.6	11.2	B,
	3726.7	11.2	Pt,	3736.6	11.3	Pi.
220133a RY PEGASI—						
	3719.6	10.7	Br,	3736.6	9.7	B.
	3727.6	10.7	Br,			
210133b RZ PEGASI—						
	3726.7	10.2	Pt,	3736.6	12.5	B
220412 T PEGASI—						
	3704.4	14.4	L.			
220714 RS PEGASI—						
	3726.7	11.0	Pt,	3736.6	11.3	B.
222129 RV PEGASI—						
	3727.6	11.3	Br,	3736.6	10.9	Pi.
222439 S LACERTAE—						
	3696.6	8.7	Ie,	3726.7	10.4	Pt,
	3709.5	9.3	Ie,	3727.5	10.2	Pi,
	3712.2	9.2	L,	3736.6	10.2	B.
	3712.2	9.2	Lh,			
225130 S AQUARII—						
	3736.5	13.4	B.			
225914 RW PEGASI—						
	3724.6	13.7	B,	3738.8	13.3	Sg.
	3724.8	13.4	Sg,			
230110 R PEGASI—						
	3694.6	13.0	Ie,	3726.7	13.4	Pt.
230759 V CASSIOPEIAE—						
	3712.6	10.7	B,	3734.6	9.8	B,
	3720.6	10.3	B,	3737.8	10.1	Sg.
	3726.7	10.4	Pt,	3749.7	9.5	Cy.
	3727.5	10.5	Pi,			
231425 W PEGASI—						
	3711.3	9.5	L,	3734.6	8.9	Hu,
	3712.1	9.8	Ch,	3736.6	9.1	Pi.
*?*1508 S PEGASI—						
	3720.7	13.0	Br,	3726.7	12.8	Pt,
232848 Z ANDROMEDAE—						
	3702.1	9.2	Ch,	3727.5	9.6	Pi.
	3726.7	9.5	Pt,			
233335 ST ANDROMEDAE—						
	3702.1	9.1	Ch,	3726.7	8.7	Pt,
	3709.7	8.6	Sg,	3727.5	9.3	Pi,
	3712.6	8.5	B,	3727.6	8.7	Sg,
	3719.5	8.7	B,	3734.6	8.0	Hu.
	3720.7	8.8	Br,			
233815 R AQUARII—						
	3702.1	9.1	Ch,	3726.7	9.2	Pt,
	3720.5	8.9	Cd,	3727.5	9.1	Ca,
	3722.6	9.2	Ly,	3736.5	9.1	Ya,
	3724.6	9.1	Ly,	3752.5	9.2	Cu,
	3725.6	9.0	Ly,	3757.6	8.8	Ms,
	3726.6	9.0	Ly,	3758.5	8.9	Ms.

VARIABLE STAR OBSERVATIONS, October 20 to November, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
233956 Z CASSIOPEIAE—						
	3697.8	13.1	Pa.	3725.8	13.8	Pa.
	3716.8	[13.7	Pa.	3732.8	13.9	Pa.
	3723.6	14.1	Wf.			
235053 RR CASSIOPEIAE—						
	3712.6	10.6	B.	3734.6	10.9	B.
	3720.6	10.8	B.	3734.6	11.2	Pi.
235309 V CETI—						
	3687.0	9.7	Bl.	3725.3	11.4	L.
	3721.7	11.5	Br.	3726.7	11.6	Pt.
235350 R CASSIOPEIAE—						
	3711.8	11.2	Ke.	3734.6	9.7	B.
	3722.6	10.3	B.	3734.6	10.1	Pi.
	3728.8	10.8	Ke.	3749.6	9.7	Cy.
235717 W CETI—						
	3727.7	10.4	Br.			
235855 Y CASSIOPEIAE—						
	3697.8	14.3	Pa.	3725.8	14.3	Pa.
	3725.7	16.	Bw.			
235939 SV ANDROMEDAE—						
	3726.7	13.4	Pt.			

Total observations: 1810; Stars observed: 315; Observers: 35.

The following observers contributed to this report: Miss Allen "Ae", Messrs. Baldwin "Bl", Barringer "Bi", Bouton "B", Braid-White "Bw", Brocchi "Br", Carr "Ca", Chandler "Cd", Chandra "Ch", Christie "Ct", Cilley "Cy", Henry "Hr", Cunningham "Cu", Miss Marris "Ha", Hunter "Hu", Miss Hutcheson "Ht", Iedema "Ie", Kanda "Kd", Keay "Ke", Kleis "Kl", Lacchini "L", Miss Lacchini "Lh", Mrs. Lytle "Ly", Marshall "Mh", McAteer "M", Mrs. Morris "Ms", Olcott "O", Parkhurst "Pa", Peltier "Pt", de Perrot "Pe", Pickering "Pi", Rhorer "Ro", Skaggs "Sg", Waterfield "Wf", and Yalden "Ya".

HOWARD O. EATON, Recording Secretary.

COMET AND ASTEROID NOTES.

Rediscovery of d' Arrest's Periodic Comet.—A cablegram received at Harvard College Observatory from the Central Bureau of Astronomical Telegrams, Copenhagen, dated December 4, announced the observation by Reid at the Cape of Good Hope of a comet in the following position:

December 1.3896 G.M.T. R.A. $22^h39^m32^s$; Dec. $-22° 31'$

The daily motion was described at 3^m east; 13' north. A second cablegram from Copenhagen identifies the object as d'Arrest's periodic comet. The comet was looked for at Northfield on the evening of December 8. A very faint diffuse object was seen near the predicted position but it was impossible to make a measurement of the position.

Professor Van Biesbroeck in a private letter describes the comet as about 9″ in diameter with a starlike nucleus.

A letter from Professor Edwin B. Frost, director of the Yerkes Observatory, calls attention to the fact that an object was seen close to the place of the d'Arrest comet by Mr. John E. Mellish on October 4. This was not reported by Mr. Mellish until October 20, but it seems quite likely that the object seen was d'Arrest's comet, two months before its detection by the Cape of Good Hope observer. The comet was much nearer the earth in October than it was in December.

The latest elements of this comet are given in *Astronomische Nachrichten* 5241, having been corrected for the perturbations by the planet Jupiter, by A. Dubiago and A. Lexin.

ELEMENTS OF D'ARREST'S PERIODIC COMET.

Epoch and Osculation 1923 Oct. 1.0 G.M.T.

$M = 2^\circ\ 25'.2$
$\pi = 317\ 33.2$
$\Omega = 143\ 31.7$ } 1925.0 $\phi = 38^\circ\ 01'.1$, $\mu = 534''.783$
$i = 18\ 03.9$
$T = 1923$ Sept. 14.7149 G.M.T.

$x = [9.99250]\, r \sin (v + 48^\circ\ 55'.6)$
$y = [9.99510]\, r \sin (v + 320\ 33.2)$
$z = [9.37541]\, r \sin (v + 268\ 47.7)$.

D' Arrest's Comet Found by Mellish, October 4.— The following letter from Professor Edwin B. Frost calls attention to the fact that d'Arrest's comet might have been observed in October had the observer made his observation known at once, even though it was but a fleeting glance.

"Under date of Oct. 20, Mr. John E. Mellish, who now lives at 1848 Forest Avenue, Wilmette, Ill., wrote:

"'A few days ago I found a large faint comet low in Sagittarius. Clouds came over at once and I never found it again. I think it went south.'

"When we wrote him for more precise information, he gave the following:

"Oct. 4, at 14^h30^m G.M.T., R.A. about 18^h10^m; Dec., -20°. Comet about 12' diameter. Very faint. No central condensation.'

"From a rough interpolation Professor Van Biesbroeck suspected that this might be an observation of comet d'Arrest. Mr. Van Biesbroeck has computed from the elements in A.N. 5241 the position of the comet at the time of Mellish's observation and finds that the comet was in R.A., 18^h8^m, Dec., $-21^\circ.1$. Inasmuch as the ephemeris just received from Copenhagen, based on the same elements, fits the positions of the comet quite closely in December, there seems to be no doubt that Mr. Mellish actually observed this comet on Oct. 4. It seems that this, in justice to Mr. Mellish, should be made a matter of record:

"I have notified Mr. Mellish to be free to call up the Yerkes Observatory on the telephone in any such contingency, so that an object may not be lost, and Professor Fox at the Dearborn Observatory has similarly offered his assistance to Mr. Mellish for the future."

EDWIN B. FROST.

Yerkes Observatory, Williams Bay, Wis., Dec. 26, 1923.

Reinmuth's Cometary Object.—This object turns out probably to be an asteroid. Professor Van Biesbroeck, of the Yerkes Observatory made a thirty minute exposure on it with the 24-inch reflector on November 11 and obtained an image that is clean cut, with no trace of nebulosity. An elliptical orbit, computed by Miss Levy and Mr. Yu of the Astronomical Department, Berkeley, California, from observations on November 5, 10 and 13, give a period of 2.56 years. The object is too faint for amateur observation.

ELEMENTS OF REINMUTH'S COMETARY OBJECT *b* 1923.

Computers	Miss Levy and Mr. Yu
Time of perihelion passage	$T = 1923$, Nov. 29.99
Perihelion minus node	$\omega = 184^\circ\ 04'$
Longitude of node	$\Omega = 232\ 10$
Inclination	$i = 11\ 20$
Perihelion distance	$q = 1.307$
Eccentricity	$e = 0.3024$
Period	$P = 2.56$ years

In a recent letter Professor Van Biesbroeck says that the following elements, given in *Beob. Zirk. 27* (Nov. 19, 1923) satisfy the later observations much better. These elements were computed by G. Stracke from observations at Heidelberg October 31, November 5 and at Bergedorf November 9. These would make the period of the asteroid (which is designated 1923 PE) 4.537 years.

ELEMENTS.

Epoch 1923, Nov. 5.5 G.M.T.

$M = 354° 54' 45''.4$
$\omega = 182\ 58\ 19.2$
$\Omega = 229\ 17\ 09.6$
$i = 16\ 18\ 04.0$
$\phi = 28\ 02\ 18.5$
$\mu = 782''.065$
$\log a = 0.437842$

Ephemeris of Comet *a* 1923. — Mr. F. E. Seagrave sends us the following ephemeris of the Dubiago-Bernard comet, computed with the aid of the elements which were given on page 681, December number of POPULAR ASTRONOMY. The ephemeris is likely to be quite uncertain, because of the long interval of time which has elapsed since the observations on which they were based, but it may be that some of our readers may be able to pick up the comet in March. The comet is steadily receding from the sun, but the earth is approaching it during February and March.

EPHEMERIS OF COMET *a* 1923.

G. Midnight 1924	α h m s	δ ° ′ ″	Log r	Log Δ
Feb. 1	17 28 56	—34 32 58.	0.19424	0.30432
9	17 27 4.	—32 39 17.	0.22362	0.29706
17	17 23 25.	—30 41 43.	0.25102	0.28656
25	17 17 40.	—28 36 40.	0.27668	0.27357
Mar. 4	17 9 34.	—26 20 29.	0.30070	0.25885
12	16 58 40.	—23 49 35.	0.32324	0.24362
20	16 45 19.	—21 0 35.	0.34448	0.22945
28	16 29 11.	—17 52 12.	0.36454	0.21828
April 5	16 10 42.	—14 26 31.	0.38348	0.21213
13	15 50 56.	—10 50 42.	0.40144	0.21301

Ephemeris of Eros (433).

(Continued from Vol. XXXI page 602.)

Gr. Midnight 1923	α h m s	δ ° ′ ″	Log r	Log Δ
Feb. 2	13 4 42	—23 18 32	0.06430	9.57495
6	13 9 26	—26 3 43	0.06678	9.57047
10	13 13 23	—28 43 20	0.06948	9.56642
14	13 16 27	—31 16 6	0.07240	9.56312
18	13 18 31	—33 40 45	0.07554	9.56035
22	13 19 39	—35 57 38	0.07882	9.55801
26	13 19 39	—38 4 0	0.08228	9.55638
Mch. 1	13 18 26	—39 59 20	0.08586	9.55528
5	13 15 58	—41 41 26	0.08960	9.55501
9	13 12 21	—43 9 51	0.09342	9.55548
13	13 7 39	—44 22 43	0.09734	9.55686
17	13 2 8	—45 20 16	0.10124	9.55912
21	12 55 30	—45 56 16	0.10540	9.56288
25	12 48 36	—46 16 29	0.10950	9.56755
29	12 41 28	—46 18 14	0.11364	9.57355

Ephemeris of Comet *c* 1922 (Baade).

Calculated by M. Jens Johannsen. (Copenhagen Observatory Circular No. 30.)

1924		α true	δ true	log *r*	log Δ
Jan.	0	3h 56m 46s	—10° 28′	0.6986	0.6368
	8	54 19	10 27	0.7042	0.6519
	16	52 43	10 19	0.7097	0.6673
	24	52 00	10 06	0.7151	0.6829
Feb.	1	51 06	9 48	0.7204	0.6984
	9	53 01	9 27	0.7257	0.7135
	17	54 40	9 04	0.7309	0.7282
	25	57 00	8 41	0.7360	0.7424
Mar.	4	3 59 56	— 8 17	0.7411	0.7559

Ephemeris of Comet *b* 1923 (Reid), Periodic Comet d'Arrest.

Calculated by Mr. B. Strömgren. (Copenhagen Observatory Circular No. 32.)

1923-24		α 1925.0	δ 1925.0	log *r*	log Δ
Dec.	29	23h 56m 21s	—18° 05′.7	0.2533	0.2485
Jan.	2	0 05 55	17 01.1		
	6	15 15	15 56.5	0.2662	0.2764
	10	24 23	14 52.1		
	14	33 20	13 48.1	0.2790	0.3034
	18	42 05	12 44.8		
	22	50 40	11 42.3	0.2916	0.3294
	26	0 59 06	10 40.7		
	30	1 07 24	— 9 40.0	0.3039	0.3542

GENERAL NOTES

Professor E. Stromgren, of the University of Copenhagen, has been called to a professorship of theoretical astronomy at the University of Berlin. (*Science*, December 21, 1923.)

Professor Solon Irving Bailey, senior member of the staff of Harvard College Observatory and Phillips professor of astronomy at Harvard since 1912, who has been in charge of the station at Arequipa, Peru, for the last two years, has been given the degree of doctor of science by the University of San Quentin at Arequipa, Peru, and at the same time was made honorory professor of astronomy at the university. (*Science*, December 21, 1923.)

A Photograph of the Members of the International Astronomical Union, taken in Rome, at the Vatican, May 10, 1922, was published in Popular Astronomy, October 1922 (Plate XXVII). In this photograph, some of the members could not be identified (4, 11, 17, 26, 29, 32, 35, 37, 38, 41, 42, 43, 62, 63, 70, are missing in the list). Anyone recognizing these members would confer a favor by communicating their names to Professor Pio Emanuelli, Vatican Observatory, Rome.

Astronomical Society of Kansas City, Mo. — At a meeting of this Society on Friday evening, November 23, held at the Gordon Place Methodist Church, open to the public, an audience of about 200 was addressed by the president of the society, Dr. E. G. Davis, on "An evening with the Stars." About a hundred slides of photographs, taken at Mount Wilson, Yerkes and other ob-

servatories, were shown, depicting the evolution of suns from spiral nebulae like 33 Triangulum, etc., to the Pleiades and Orion type stars.

Dr. Davis was followed by Mr. Donald P. Beard, who gave a short sketch of the results recently achieved by Dr. C. G. Abbot at Mount Wilson, and spoke in popular language of the discovery of two thermal maxima in the spectrum of Rigel (β Orionis).

There is considerable local interest in Astronomy and the city editor of the "*Kansas City Star*," Mr. George B. Longan, who is himself an enthusiastic amateur astronomer, gives as much space as he can to the subject.

A Brilliant Meteor. — A splendid fireball was seen by G. Van Biesbroeck at Williams Bay (Wis.) on the morning of Dec. 6. At $2^h\ 52^m$ a. m. C.S.T. ($20^h\ 52^m$ Gr.M.T. of Dec. 5) it suddenly illuminated the N. W. sky, and for a moment the landscape brightened up as if under full-moon light. The fireball was white with a slight greenish hue. It left a short trail, only 2° or 3° long, which appeared orange at first and became red toward the end, after 3 or 4 seconds. The ball itself seemed to have a diameter of some 20′ but this is probably an effect of radiaton. The sparkling nucleus did not last more than 2 seconds. It vanished at a low altitude, but clearly before reaching the horizon. The position was well recorded relatively to the stars and located at once by means of Norton's star atlas.

	α	δ	
Apparition	$0^h\ 56^m$	+43°8	1920.
Disappearance	23 33	42.0	

Some 7 or 8 seconds later a third magnitude meteor was noticed running nearly parallel to the fireball, but 3° farther S. and 10° towards the east. Both objects seemed to emanate from Gemini.

Popular Lectures In Astronomy.—The following is a list, given in the December 1923 number of *Publications of the Astronomical Society of the Pacific*, of popular lectures on astronomical subjects, arranged by the Lecture Committee of the Society to be delivered in Native Sons Hall, San Francisco.

November 8, 1923—"Problems of Astronomy," by Dr. R. G. Aitken, Associate Director of the Lick Observatory.

December 7, 1923—"Total Eclipses of the Sun," by Dr. J. H. Moore, Astronomer in the Lick Observatory.

January 18, 1924—"The Story of the Telescope," by Dr. R. T. Crawford, Professor of Astronomy in the University of California.

February 15, 1924—"The Physics of Astronomy," by Dr. E. P. Lewis, Head of the Department of Physics, University of California.

March 21, 1924—"The Trend of the Recent Astronomical Research," by P. W. Merrill, Astronomer in the Mount Wilson Observatory.

The program is one that may well be imitated in other large cities. The lectures will all be illustrated and worded in non-technical language, and are free to the public.

It is interesting to note that three generous members of the Society have contributed $100 each toward the expenses of the course of lectures, an example worthy to be followed by others who wish to help in advancing the cause of astronomy and other sciences.

New Observatory in France.—A clipping sent us from the *New York Times* gives what purports to be an Associated Press dispatch from Geneva, November 14, to the following affect:

"What will be the largest observatory in the world, with a telescope more powerful than those at Mount Wilson or Greenwich, is to be built on Mount Saleve, located on French territory, a few miles from Geneva.

"The observatory will be the gift to France of the Hindu millionaire, engineer and scientist, Assan Dina, and his wife, who was Miss Mary Wallace-Shillito, of Cincinnati. The bulding, instruments and installation will cost $6,000,000. The telescope lens will have a diameter of 105 inches, or five inches greater than the Mount Wilson instrument."

This is the second report we have seen about the proposed new observatory in France, and is much more definite than the first, but needs confirmation. It is possible that the reporter got francs mixed with dollars, and he certainly confused mirror with lens. The Hooker telescope at Mount Wilson is a reflecting telescope, with a concave mirror of 100 inches diameter. Six million francs would be equivalent at present rates of exchange to roughly $300,000.

However, we will not be jealous of the French if they get an observatory and telescope larger and better than any other in the world!

Methods of Mechanically Relating Sidereal and Solar Meantime Clocks are set forth by Samuel W. Balch of New York in an article in *Horological Journal*, London, for September, 1923.

The problem is to find a gear train which will represent the ratio, and involves the discovery of a close factorable equivalent of the ratio. The ratio and the close equivalent are as follows:

$$\frac{365.242197}{366.242197} = \frac{60}{8} \times \frac{61}{55} \times \frac{37}{59} \times \frac{13}{68}$$

The timepiece has hour and minute hands with connecting trains for each kind of time. Like spindles, as the spindles which carry the minute hands, are connected by a train of eight gears with the above numbers of teeth, the eight tooth gear being on the meantime minute spindle and the thirteen tooth gear being on the sidereal time minute spindle. The article shows how the train can be combined with the trains which relate the hour and the minute hands so that but one additional spindle is required to connect the two trains.

The article also gives a method for connecting observatory sidereal and meantime clocks through their chronograph circuits. They are coupled through a contact which is intermittently closed by a suitable train. The sidereal clock is used as the master clock and requires no modification except that a circuit should be branched from the chronograph circuit so that it will not be interrupted in the customary way to indicate the commencement of the minutes and half minutes. The mean time clock is provided with a device which will bring it into synchronism with the beats of the sidereal clock at intervals. This clock is also provided with a special train to give the following ratio:

$$\frac{15}{44} \times \frac{43}{41} \times \frac{17}{74}$$

The fifteen toothed gear is carried by the seconds spindle and the seventy-four toothed gear carries means for closing the chronograph circuit of the sidereal

clock for a period of about one second at each revolution, which will be at intervals of about twelve minutes. It is at these intervals that sidereal and meantime clocks beat in synchronism for a few beats with the pendulums swinging the same way, and the circuit closed by the contact-carrying gear is used to correct the beats of the meantime clock if they do not coincide perfectly with the beats of the sidereal master clock at the moment when the circuit is closed. The above is a differential train based on the ratio 266992 : 267723, and has a present error of 0.035 second a year which is diminishing.

Apex of the Globular Clusters.—In *Publications* of the Astronomical Society of the Pacific, December 1923, Mr. Knut Lundmark gives the results of a study of the motion of the globular clusters. Radial velocities are available for 16 of these clusters and from them Mr. Lundmark obtains for the position of the apex, or direction of their average motion,

Right Ascension $21^h.3$; Declination $+64°$.

The velocity of the group of clusters comes out —266 kilometers per second.

These results are of course very uncertain because of the small number of clusters considered.

Duplicity of Omicron Ceti. — In Harvard College Observatory Bulletin 792 announcement is made of the discovery by Professor Aitken that Omicron Ceti is a visual double, as suspected by Professor Joy. The distance is given as 1".01 in the position angle 132°.3.

On plates taken at the McCormick Observatory on October 8, 1923, the image of this variable is distinctly elongated in a southeast northwest drection. The position angle, as determined from rough settings on the circle of a Repsold measuring machine, is 113°. No estimate of the distance of the components is possible. A separation less than a second of arc—corresponding to 0.05 mm. on our plates—would probably escape detection.

Five plates taken for the determination of the parallax of this star between September 13, 1914 and November 25, 1914, when Omicron Ceti was also near minimum, give no evidence of elongation of the images of the variable. The plates are probably not good enough to show the presence of the companion if it were there.

HAROLD L. ALDEN.

McCormick Observatory, University, Virginia.
December 18, 1923.

Weather Proverbs and Paradoxes. — By W. J. Humphreys, Ph. D., meteorologist and physicist, United States Weather Bureau. Williams and Wilkins, Baltimore, Maryland, publishers. $1.50. (Foreign countries $1.75.)

In this little book of 125 pages Professor Humphreys has selected from other collections of "Weather Proverbs" those proverbs which really have some scientific basis, and explains in a very popular way the meanings of the sayings and the principles which lie back of them. The book can be read in a few hours and is well worth a place in any man's private library. It is well illustrated with photographs of various meteorological phenomena.